OBSERVATIONS ON THE DEVELOPMENT OF *CULEX PEUS* SPEISER IN SOUTHERN CALIFORNIA DAIRY WASTEWATER PONDS

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ABSTRACT

The immature developmental cycle of *Culex peus* Speiser in dairy wastewater ponds varied from 7 days to 12 days during the observation months of April to September, 1977. Oviposition was initiated in April and terminated in early January of the following year. The mean developmental time during the summer was 10.2 days at an average water temperature range of 69.8 - 81.5° F. The mean developmental period during the spring was 15.2 days at a mean water temperature range of 64.3 - 75.6° F. The mean number of eggs per raft was 269. Chemical analyses of the dairy waste water revealed an ammonia content of up to 150 ppm and a dissolved oxygen content approaching zero.

INTRODUCTION.-The agricultural area of the Chino Valley is located in both Riverside and San Bernardino Counties. Nearly 500 dairies operate within about four miles or less of suburban housing developments. Inevitably, the residents adjacent to the dairy area experience problems with various insects, particularly mosquitoes. It is not uncommon to collect over 800 male and female mosquitoes in one week in a single New Jersey light trap located in the rural/suburban interface. The most frequently trapped species are *Culex peus* Speiser and *Culex quinquefasciatus* Say, with the former predominating. Though not a common biter of humans, *Cx. peus* has been shown to harbor both western equine and St. Louis encephalitis viruses (Hammon and Reeves, 1943a, b; Emmons, Grodhous, and Bayer, 1974). The sources wherein these species breed are ponds used to impound water resulting from the washing of dairy cows. In many, if not most instances, the ponds contain varying amounts of floating organic materials that clump together forming moving islands. In addition, the banks of the ponds support weed growth which frequently overhangs the water's edge. The result of the above is a multitude of protected habitats optimum for the aquatic portion of the mosquito life cycle.

In 1977, the following study was initiated to ascertain specific information regarding the life cycle of *Cx. peus* in an effort to increase the effectiveness of control measures applied by the Northwest Mosquito Abatement District.

MATERIALS AND METHODS.-Two dairy waste-water ponds were selected in the western agricultural area of the District. These sources had a history of producing high numbers of mosquitoes if left untreated. The ponds were approximately one-half and three-quarters of an acre in size, with moderate floatage (less than one-fifth the pond surface area). Oviposition devices and rearing chambers, fabricated from one inch sheet styrofoam and one quart plastic cups (Figure 1.), were placed in each pond. Water and air temperatures were recorded using maximum/minimum thermometers. Chemical tests, other than pH, were performed by a commercial laboratory.

Each observation day, any egg rafts laid during the previous 24-hour period were removed. The number of eggs per raft and the raft dimensions were documented in the laboratory using a stereo scope and ocular micrometer. Randomly selected egg rafts were placed in each rearing chamber in the dairy pond and allowed to progress through the life cycle. On a daily basis, a sample of 30 immatures were removed from the chamber. The life cycle stage of each specimen was noted and each was returned to the chamber. Species other than *Cx. peus* were discarded. When pupae occurred, they were removed, counted, and transferred to identical chambers for continued development in the pond environment. As adults emerged, they were removed by aspiration, counted, and sexed.

From March through November, 1977, observations were made daily or bi-daily as deemed necessary. During the months of December, 1977, through February, 1978, observations were performed on a three day cycle.

RESULTS AND DISCUSSION.-Chemical analyses of the ponded waste water showed dissolved oxygen to be in the range of 0.0 to 0.6 ppm. The pH ranged from 7.0 to 7.8, and the ammonia (NH_3) was between 100 and 150 ppm. By way of comparison, typical water supporting mosquito fish (*Cambusia affinnis*) usually has a dissolved oxygen content range of 7 to 15 ppm, with the minimum being 1.0 ppm. The usual pH range is 7.5 to 10.0, and the ammonia ranges from 0.1 to 1.0 ppm, with a maximum of over 5 ppm (Coykendall, 1980).

The larvae develop readily in these polluted conditions in concentrations greater than 1500 per dip (personal observation). During this study, the immature densities ranged from zero in February and March to nearly 1000 per dip in August and September.

The number of eggs present in the rafts sampled ranged from 152 to 374 with the mean being 269. The large standard deviation (58) indicates a wide variability in the number of eggs laid by each female in each raft (Table 1.). The range of the raft width values is small (SD=0.3)

[1]Study was conducted while in the employ of the Northwest Mosquito Abatement District, 6851 Granite Hill Drive, Riverside, California 92509.

Table 1.-Egg Raft Characteristics, *Culex peus* Speiser.

	Range	Mean	Std. Dev.	N
Num.eggs/raft	152 - 374	269	58	30
Raft length	8.1 - 11.0 mm	9.4 mm	0.8	30
Raft width (maximum)	3.5 - 4.8 mm	4.3 mm	0.3	30

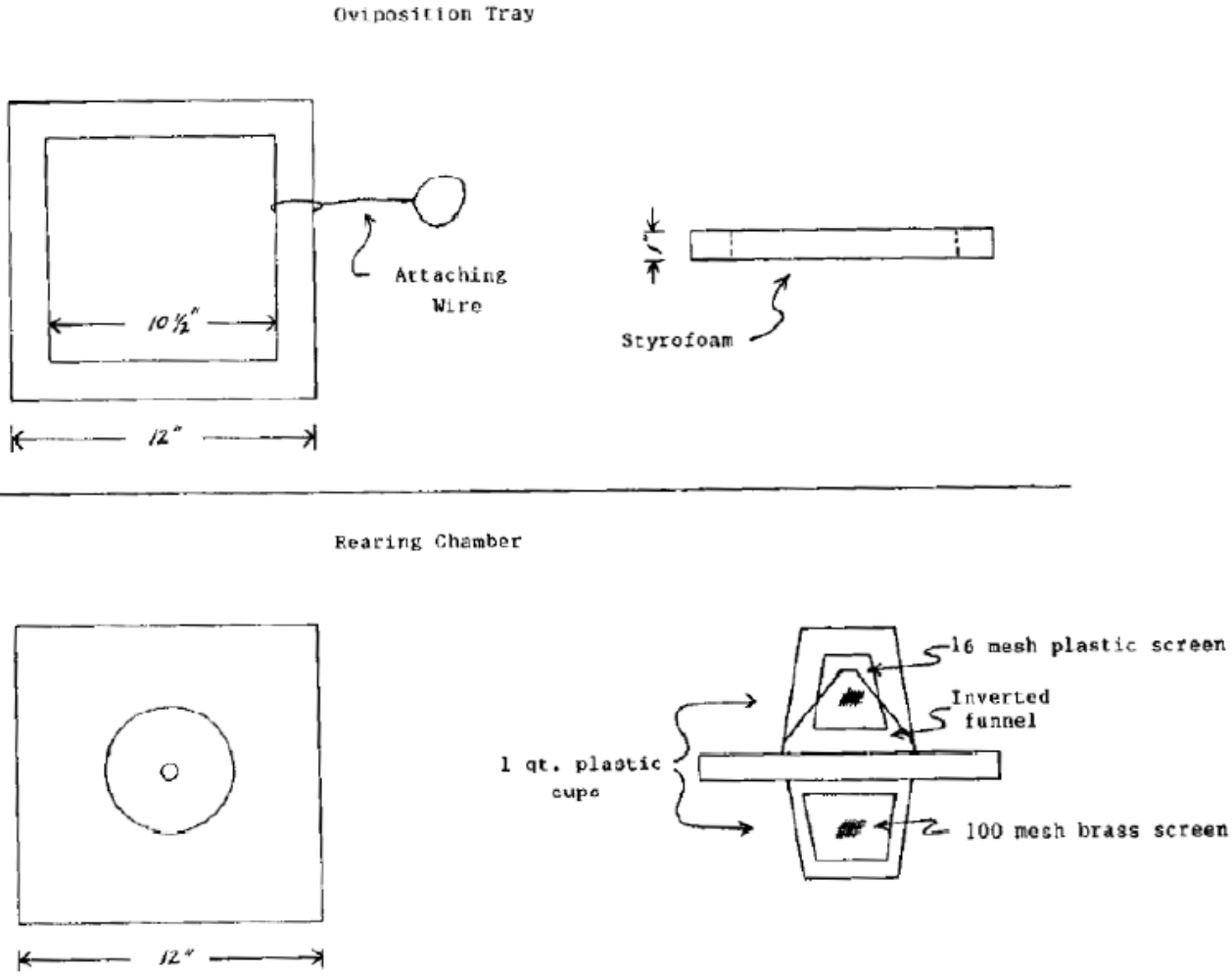

Figure 1.-Oviposition Tray and Rearing Chamber, *Culex peus* Speiser.

whereas the range of the raft length values is larger (SD=0.8).

The first egg rafts laid in the oviposition trays were observed on April 7. The water temperature ranged between 64 and 74° F (mean = 69°F), with an ambient temperature of 66° F at 9:00 AM. The range of the air temperature was 42 to 88° F, with an ambient reading of also 66° F. Though the ambient water and air temperatures were the same in the above instance, the ambient air temperature does not appear to be a satisfactory parameter by which to judge the probability or possibility of egg deposition as readings varied greatly during a given time frame. Ambient water temperatures tended to be more restricted in their ranges. Oviposition was sporadic through the months of April and May. In June, the number of rafts deposited in the trays increased dramatically. When rafts were observed, the average number present was 137. The maximum rafts counted in one tray was 630. During July, the rafts found per tray decreased to an average of 27 - the maximum noted was 175. The mean for August was 38, with a maximum deposition of 75 rafts. After August, oviposition was reduced to an average of less than 10 rafts per observation, excluding a one day peak of 223 rafts on October 24. Sporadic oviposition again occurred during November and December. The last observed raft deposition (a single raft of 97 eggs) was on January 9, 1978, at 9:30 AM with a water temperature range of 49 to 55° F and an ambient water temperature of 50° F (Figure 2).

Of the initial volume of 1897 eggs, 1571 individuals reached the fourth instar stage, indicating a survival rate in the rearing chambers of 82.8% (Table 2). The number of adults produced from the aforementioned larvae totalled 1442 for a 91.8% survival rate. The overall survival rate of the chamber reared specimens, based upon the initial egg count and ending adult tally, was 76.0%. In the natural state, the number of surviving adults would be much less. In general, mosquito species exhibit overall survival rates of less than 5% (Reisen and Siddiqui, 1979; Reisen et al, 1982; Reisen et al, 1986).

The observed sex ratio of *Cx. peus* followed the expected norm of 1:1 (Table 3). On the first day of emergence, male mosquitoes were predominant with a ratio of about 2:1. The situation was reversed on day two. The final day of emergence produced females in the ratio of nearly 3:1. The majority of adults were produced

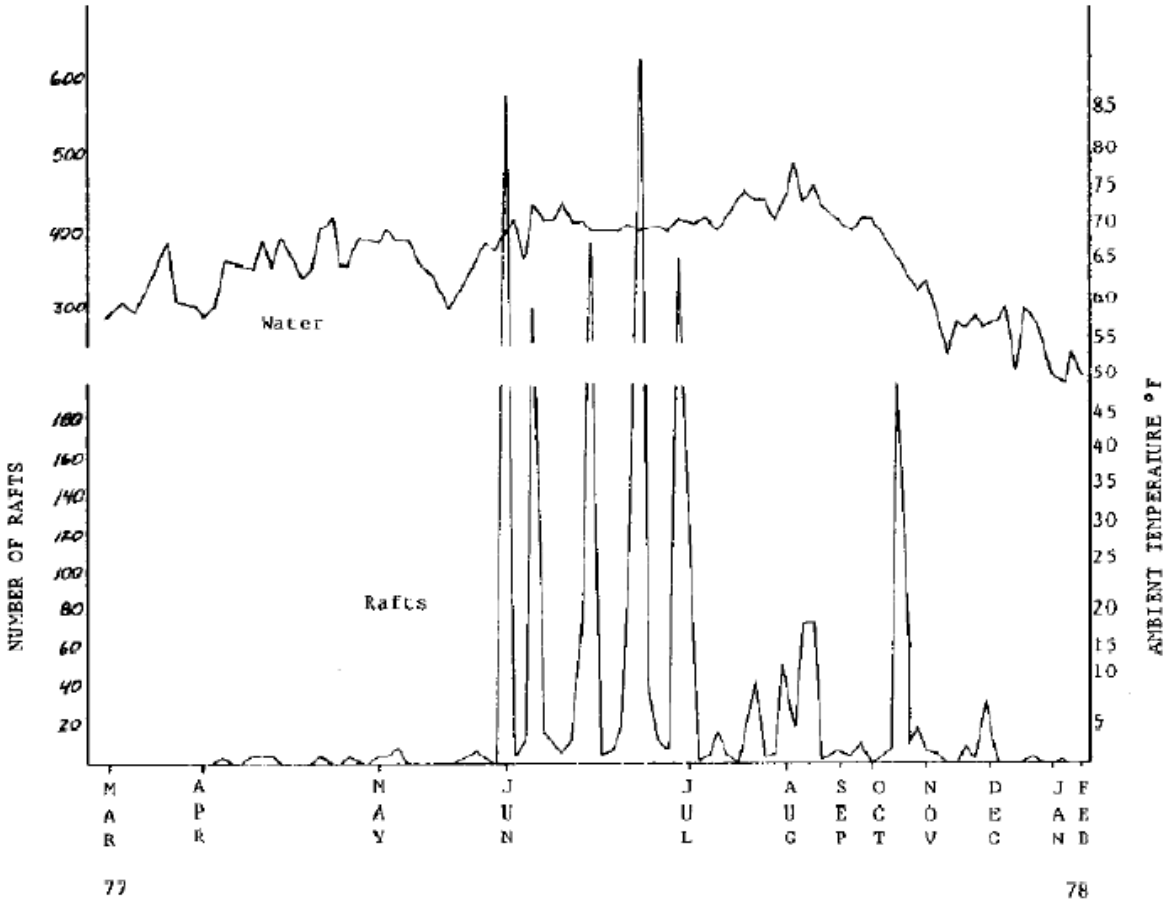

Figure 2.-Seasonal Egg Raft Deposition, *Culex peus* Speiser.

on days one and two (93%), while day three yielded the lowest volume (7%).

The developmental time spans of successive stages, during the months of June through August, were significantly shorter than those noted for the months of april and May (Table 4). Note that the maturation of the first and second instars during the time periods cited in Table 4 are very similar, even though statistically different. Greater time differentials occurred from the third instar through the adult stage. The later developmental stages also exhibited greater ranges of values. Similar developmental time spans were noted in urban catch basins (Pfuntner, 1978) and under laboratory conditions (Bohart and Washino, 1978). Ball and Chao (1956) observed that the cycle from egg to adult required 18 to 26 days at 72° F.

As the Northwest Mosquito Abatement District uses oils such as Golden Bear 1356 to achieve control, treatments must be completed on a cycle that produces mortality of the immature stages prior to adult emergence. During the summer months, the cycle should be less than ten calendar days as the adult emergence begins on developmental day ten. Based upon the observed oviposition in the first week of April, initiation of control activities in the spring should begin by April 15. Mosquito activity could begin either before or after the above date, of course, depending upon the water and air temperatures, diurnal photoperiod, and the presently unknown habits of *Cx. peus*. It appears, however, that periodic checks of sources for ambient water temperatures approaching 66° F, between 9:00 and 10:00 AM, could forewarn field personnel of impending oviposition activity.

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Table 2.-Survivorship of *Culex peus* Speiser in Rearing Chambers Suspended within Dairy Wastewater Ponds.

Raft Number	Number of Eggs	Number of 4th Instars	Number of Adults Produced
1	152	129	120
2	218	174	161
3	374	292	273
4	305	256	230
5	276	237	215
6	252	214	196
7	320	269	247
Total	1897	1571	1442

Percent immatures surviving: 82.8
Percent adults hatching: 91.8
Percent overall survival: 76.0

Table 3.-Comparison of Adult Emergence by Sex, *Culex peus* Speiser.

Day	Males	Females	Combined	Percent	Ratio (male to female)
1	214	106	320	58	2.02 : 1
2	62	133	195	35	1 : 2.15
3	8	30	38	7	1 : 3.75
Total	284	269	553		

Table 4.-Development Duration by Stage, *Culex peus* Speiser.*

Date Range	Avg Days to 1st Instar	Avg Days to 2nd Instar	Avg Days to 3rd Instar	Avg Days to 4th Instar	Avg Days to Pupa	Avg Days to Adult	Avg Water Temp min	max	ambient
4/22 - 5/10 **	1.9 SD = 0.7 R = 1 - 3	3.8 SD = 0.4 R = 2 - 4	5.4 SD = 1.0 R = 4 - 6	7.9 SD = 1.7 R = 6 - 10	10.2 SD = 1.8 R = 8 - 12	15.2 SD = 2.2 R = 13 - 18	64.3 ~ SD = 2.4 R = 60 - 68	75.6 ~ SD = 4.2 R = 69 - 82	67.2 ~ SD = 3.1 R = 62 - 74
6/14 - 9/3 +	1.3 SD = 0.5 R = 1 - 2	2.4 SD = 0.6 R = 2 - 3	4.5 SD = 0.6 R = 4 - 5	6.4 SD = 1.3 R = 5 - 8	8.3 SD = 1.2 R = 7 - 9	10.2 SD = 1.6 R = 9 - 11	69.8 ~~ SD = 2.3 R = 62 - 74	81.5 ~~ SD = 2.9 R = 76 - 90	72.2 ~~ SD = 2.0 R = 70 - 76
Statistical Comparison of Above ++	t = 2.7 (sig dif)	t = 3.3 (sig dif)	t = 3.1 (sig dif)	t = 2.8 (sig dif)	t = 3.5 (sig dif)	t = 4.6 (sig dif)	t = 34.6 (sig dif)	t = 26.8 (sig dif)	t = 29.4 (sig dif)

* - stage designation based upon 50% Of specimens exhibiting stage characteristics
** - N=4
+ - N=5
++ - Student's t at 95% CL
[illegible] - N=19
[illegible] - N=30

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