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A SHIFT IN CULEX PIPIENS OVIPOSITION INITIATION IN EAST-CENTRAL ILLINOIS DURING 1991

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ABSTRACT:

During 1991, egg raft oviposition frequencies of Culex pipiens and Culex restuans were monitored daily from late April through September in east-central Illinois. During the week of June 19, the abundance of Cx. pipiens egg rafts increased from 3% to 19%. The percentage of Cx. pipiens rafts continued to increase throughout the season and became the predominant portion of the Culex population (cross-over) during the week of July 10, 1991. During the weeks of July 24 and September 4, 1991, comparable Cx. pipiens oviposition peaks were observed. Cx. restuans egg raft deposition reach a peak in the week of June 12 and was followed by a continuous gradual decline through mid September. The initiation of Cx. pipiens oviposition in June, 1991 was approximately a month earlier than the beginning of egg raft deposition in the previous three years. A comparison of 1988 and 1991 cooling degree day accumulations during the period of Cx. pipiens oviposition initiation revealed an overlap of these ranges.

INTRODUCTION

During the last four years, Culex oviposition has been monitored daily to establish the character of Culex abundance patterns in east-central Illinois. Heretofore, circumstantial evidence has been accumulated concerning the abundance characteristics of Culex pipiens Linnaeus and Culex restuans Theobald populations between and during St. Louis Encephalitis (SLE) epidemics. Increased Cx. pipiens abundance has been reported during and after several SLE outbreaks (Lumsden 1958, Ranzenhofer et al. 1957, Reeves 1965, Kokernot et al. 1969). In the midwestern United States, the importance of vector population abundance and the association of abundance with SLE incidence has been difficult to establish because regular collecting intervals and standard sampling techniques have not been maintained throughout interepidemic periods and SLE outbreaks (Mitchell et al. 1980). Although anecdotal evidence suggests a positive relationship between SLE transmission and increased vector abundance, Mitchell et al. (1980) believed that the existence of a striking association between Culex species abundance and epidemic SLE virus activity was not indicated. Tsai and Mitchell (1989) believed that baseline data describing Cx. pipiens and Cx. restuans abundance patterns will be required to document significant interepidemic temporal and quantitative changes that may play a role in SLE epidemic development. In view of the drought conditions in 1988, and conflicting species abundance and SLE incidence patterns (Lumsden 1958, Mitchell et al. 1980, Monath 1980), Culex oviposition monitoring was initiated during 1988 (Steinly and Novak 1990) and continued through 1991 to characterize egg raft deposition patterns.

The purpose of this investigation was to describe Cx. pipiens and Cx. restuans daily, weekly, and seasonal oviposition abundance patterns during 1991. The weekly relative abundance of Cx. pipiens and Cx. restuans egg rafts are reported. The dates of Cx. pipiens oviposition initiation during 1988 and 1991 are compared with cooling degree day accumulation patterns.

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MATERIALS AND METHODS

Egg raft deposition frequencies, an estimate of potential female abundance, were monitored with 7 white ovitraps that were distributed along a north-south and east-west transect in Urbana and Champaign, respectively. Culex rafts were counted, recorded, and removed daily from the ovitraps with a fine artist brush which eliminated egg raft break-up. After rafts were removed from the traps, the surface water was skimmed with a standard tea strainer to eliminate the accumulation of fungal/bacterial scum and plant debris. The accumulation of bacterial and fungal blooms may radically alter surface tension and inhibit Culex egg raft deposition.

Oviposition traps were constructed from 20 L plastic buckets. All buckets had 6 equally spaced 7.65 cm holes drilled in the sides that were approximately 10.2 cm below the bucket opening. The traps were partially filled with 15 cm of water that was enriched with rabbit chow pellets. A cup (750 ml) of rabbit chow was wrapped in cheese cloth and immersed in the trap water for 24 hours. Initially, the infusion was diluted, 1/3 infusion to 2/3 tap water, before the buckets were placed in the shade. Rabbit chow pellets were reintroduced into all buckets every 10 days for 24 hours to insure that an adequate concentration of organic matter was suspended in the water column. Plastic oviposition trap lids were taped on and/or weighted with a brick to eliminate possible disturbance of the bucket contents by large vertebrates. The oviposition traps were placed along the two transects on April 21, 1991. Ovitraps were removed from the field sites on October 16, 1991, because egg raft production ceased and/or the maximum nighttime ambient air temperature was consistently below 13° C.

Weekly, egg raft subsamples of 90-400 rafts were placed in petri dishes lined with moist facial tissue and returned to the laboratory for hatching and rearing. Weekly egg raft subsample size was limited by field abundance and laboratory rearing space. In the laboratory, individual egg rafts were placed in petri plates half-filled with tap water. After eclosion, the larvae were fed a suspension that contained tap water and finely ground Tetramin fish food. The use of a suspension, rather than powdered Tetramin, reduced bacterial mat growth in the rearing dishes. During pre- and post-hatch periods, the immature stages were exposed to a natural light/dark cycle and room temperature. Third and fourth larval instars were killed with ethyl alcohol and identified to species. The percentages of Cx. pipiens and Cx. restuans were calculated for each weekly subsample. Additionally, percent abundance (i.e. relative abundance) was calculated for daily samples throughout the season. The total number of egg rafts deposited in all oviposition traps and the weekly percentage of each Culex species were multiplied to calculate the weekly number of rafts deposited by Cx. pipiens and Cx. restuans.

Daily Cx. pipiens and Cx. restuans raft frequencies were compared to cooling degree day accumulations (CDD) to establish any relationships between the 1988 and 1991 oviposition initiation patterns. Oviposition initiation is defined as sustained raft deposition occurring on four or more days within a seven day period. CDD is the number of degrees by which the mean daily temperature exceeded the base temperature of 65° F. The accumulation of daily CDD is composed of the sum of the daily mean deviations above 65° F during May through September.

RESULTS AND DISCUSSION

Cx. restuans initiated oviposition on May 1, 1991 and was the only Culex species collected until the week of May 29, when Cx. pipiens egg rafts were first collected. The mean number of Cx. restuans egg rafts/locality/week increased until the week of June 12, 1991 (Figure 1) while the relative abundance i.e. percent of Cx. restuans egg rafts in the Culex population decreased (Figure 2). After a maximum mean deposition peak of 59 egg rafts/locality/week (A) during the second week in June (Figure 1), weekly raft numbers and relative abundance of Cx. restuans decreased gradually through September. Although the number and relative abundance of Cx. restuans egg rafts continued to decrease after the second week in June, this species remained a viable part of the Culex population (Figures 1 & 2).

During the week of June 19, the relative abundance of Cx. pipiens egg rafts increased from 3% to 19% and became the major portion of the Culex population (cross-over) during the week of July 10, 1991 (Figure 2). Coincidentally, cross-over occurred during the same week in 1988. In general, the total absolute number of Culex egg rafts/locality/week reach a maximum of 684 at a mean deposition of 98 egg rafts/locality/week during the week of July 24, 1991 (Figure 1). The first peak of Cx. pipiens oviposition (C) was followed by a second peak of comparable magnitude (D) during the week of September 4, 1991 (Figure 1). Both the early and late Cx. pipiens oviposition peaks (C and D) consisted of 80 egg rafts/locality/week (Figure 1). Similarly, a second late season oviposition peak was observed during the week of September 25, 1988 (Steinly and Novak 1990). Additionally, the mean weekly egg raft deposition peaks of Cx. pipiens and Cx. restuans exhibited similar magnitudes in 1988 (Steinly and Novak 1990).

Although 1988 and 1991 were dryer and hotter than normal years in east-central Illinois, the annual accumulations of CDD during 1988 and 1991 were not comparable. Examination of temperature records revealed a difference in early and late season CDD accumulation patterns. Although the total accumulations of CDD for both years through September were similar, CDD accumulation started in early May 1991 and these higher than normal levels of accumulation were sustained through September, while in 1988 the CDD accumulation patterns were near normal until mid June (Figure 3). During the week of June 12, 1991, Cx. pipiens egg raft deposition was initiated within a CDD range of 297 to 394 (Figure 4). In 1988, Cx. pipiens oviposition was first observed on June 27 at a total CDD accumulation of 345. A comparison of 1988 and 1991 CDD accumulations during the period of Cx. pipiens oviposition initiation revealed an overlap of CDD ranges (Figure 5). The date of Cx. pipiens oviposition initiation in 1991 represents a shift or displacement of 3 weeks. Tentatively, the overlapping CDD accumulation ranges suggests that temperature and/or the rate or pattern of temperature accumulation may be responsible in part for triggering Cx. pipiens oviposition. Further analysis will be required to identify additional abiotic and biotic stimuli that may play a role in the initiation of Cx. pipiens oviposition in east-central Illinois.

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Table 1. Calculation of Estimated *Culex pipiens* Female Survival

A

$$\frac{\text{Mean Number Eggs/Raft}^*}{\text{Gender Number}} \text{(Number of Rafts) (Survival Rate/Day)} = \text{(Number Surviving Females Day 1)}$$

B

(Number Surviving Females Day 1) (Survival Rate/Day)= Number Surviving Females Day 2

Mean Number Eggs/Raft/Week in July *

Gender Number	=	2
Mean Number of Eggs/Raft	=	200
Survival Rate/Day	=	0.82%

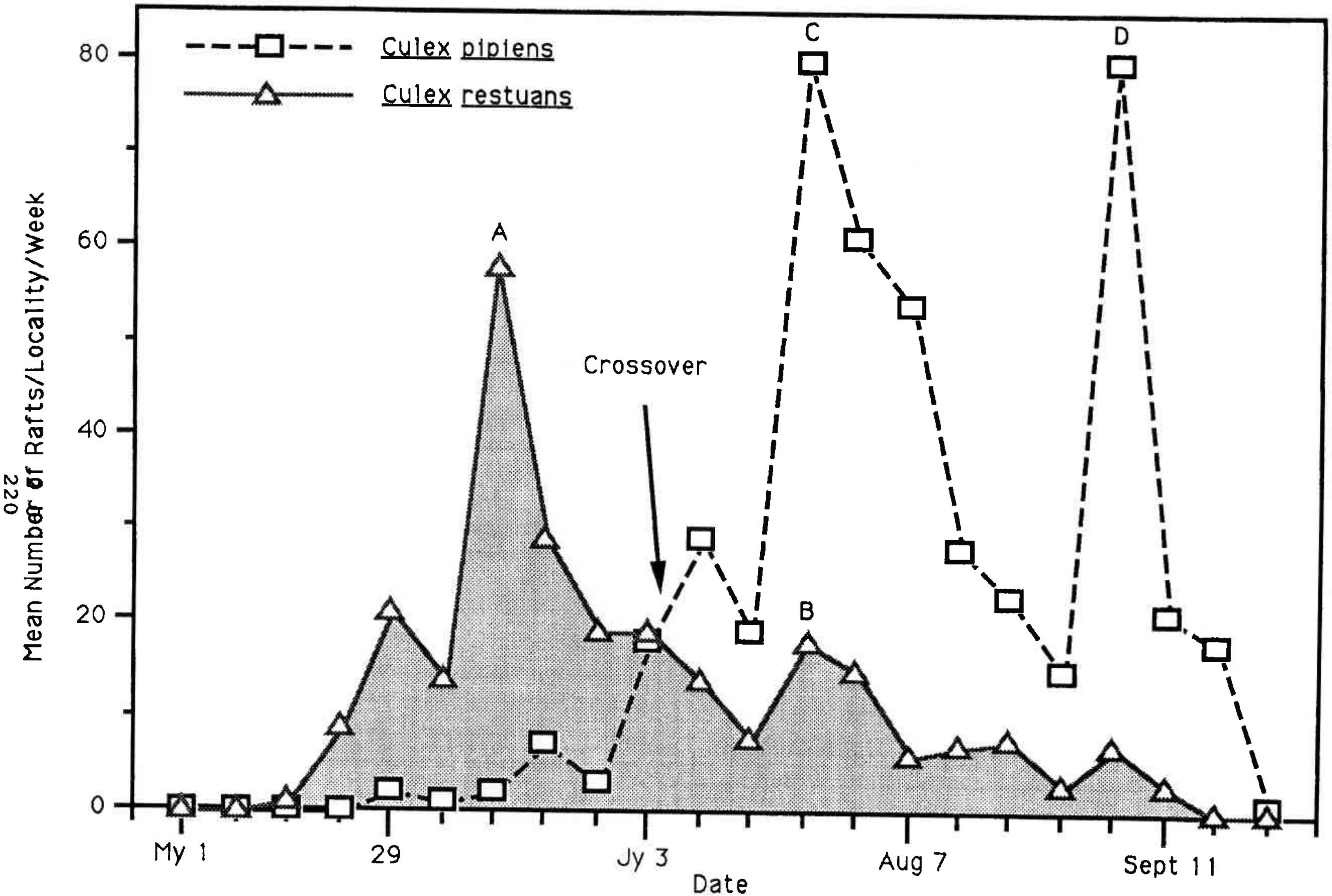

Figure 1. Mean _Culex pipiens_ and _Cx. restuans_ Raft Deposition in East-Central Illinois During 1991

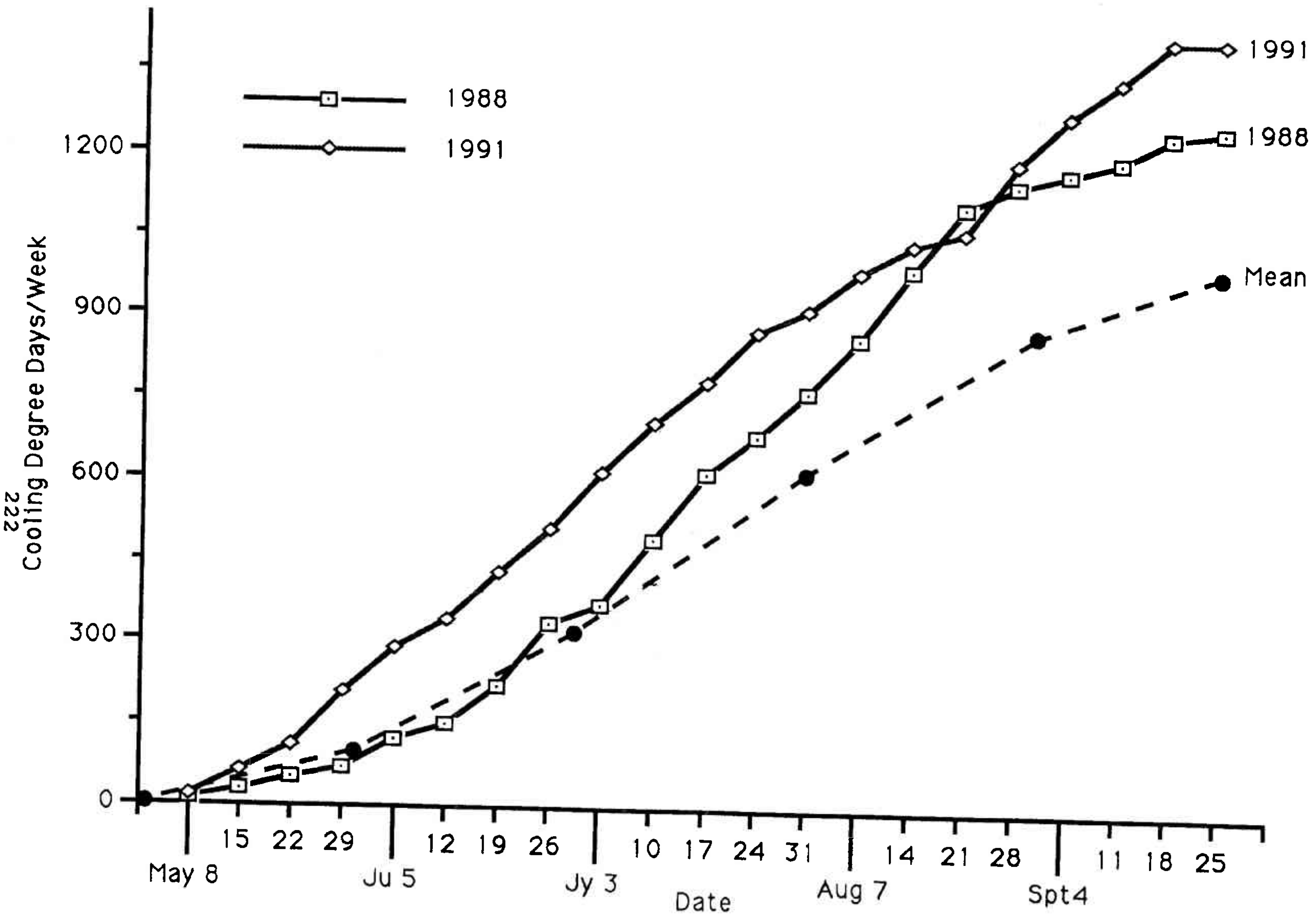

Figure 3. Weekly Accumulation of Cooling Degree Days in East-central Illinois

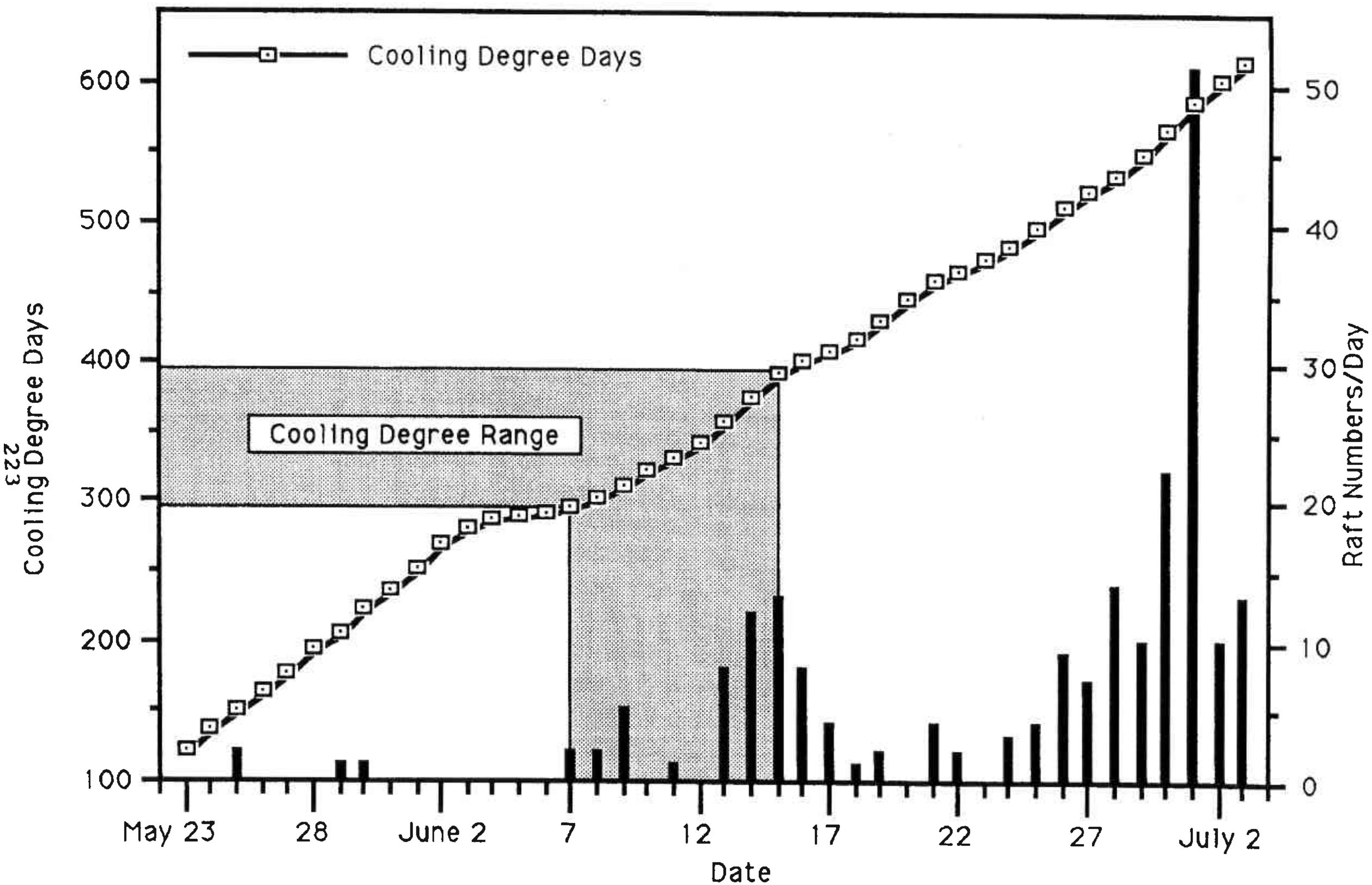

Figure 4. <u>Culex</u> <u>pipiens</u> Oviposition Initiation In East-central Illinois During 1991

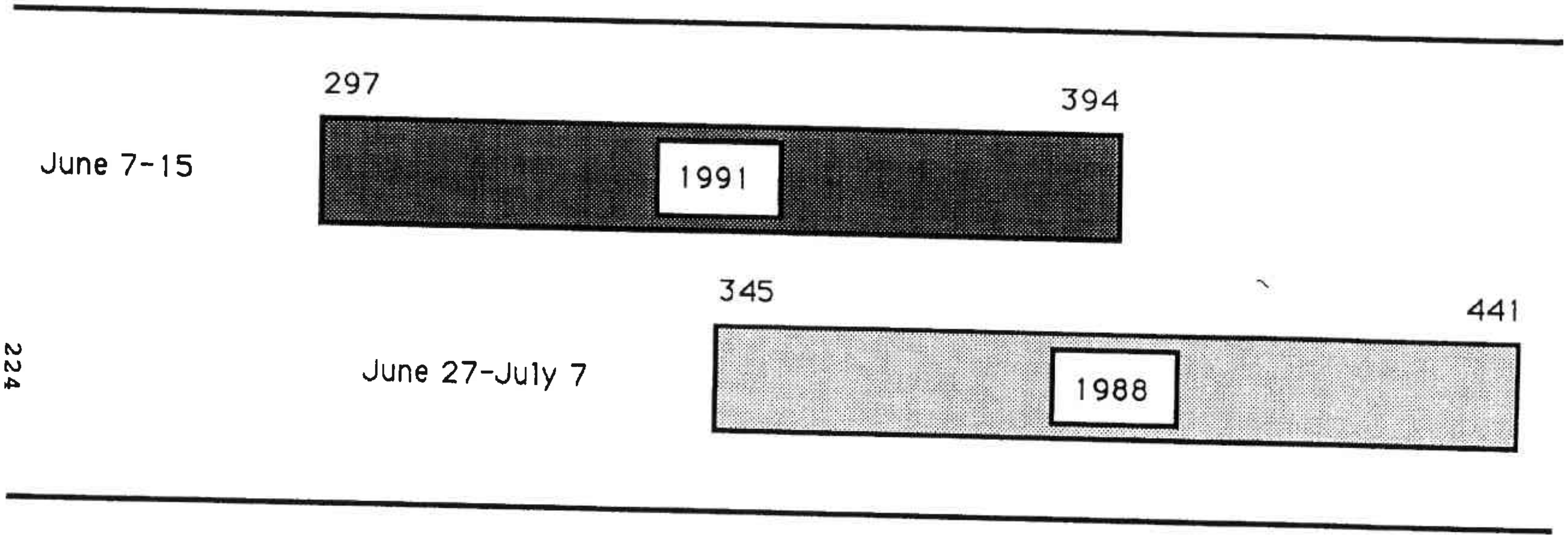

Figure 5. Cooling Degree Day Ranges During The Initiation of Culex pipiens Oviposition in 1988 and 1991