TEMPORAL ABUNDANCE AND PERCENT INSEMINATION OF NEWLY-EMERGED ADULT FEMALE *PSOROPHORA COLUMBIAE* NEAR THE LARVAL HABITAT[1]

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ABSTRACT. The temporal abundance and percent insemination of newly-emerged adult female *Psorophora columbiae* were investigated in riceland sites near Anahuac, TX. Pre- and postmating nights were characterized by low numbers of females and little mating activity (no significant increase in percent insemination) occurring in the study site. Mating nights were characterized by high female abundance in the study site before sunset then steadily decreased until a stable, low level of abundance was reached approximately 2 to 2.5 hr after sunset. On mating nights, percent insemination of female mosquitoes in the study site remained low until sunset, after which it steadily increased until a maximum was reached about 2 hr after sunset. On each mating night, approximately 2 to 2.5 hr after sunset, a mass exodus from the site by primarily mated females with some males was observed.

INTRODUCTION

Psorophora columbiae (Dyar and Knab) is one of the most important mosquito pest species breeding in Texas ricelands (Olson and Newton 1973). During times of peak abundance this mosquito can be a threat to livestock (Bishopp 1933) and humans (Olson and Newton 1973). Wide area application of ultra-low volume adulticide sprays (primarily malathion) is the primary method of adult *Ps. columbiae* control in the Texas rice belt. This method of control is expensive, labor intensive and subjects large areas of land to insecticide exposure. We believe that adult *Ps. columbiae* populations may be more effectively controlled if adulticide spot-treatment sprays are used soon after emergence while the mosquitoes are still concentrated near the larval habitat. This will require a more detailed knowledge of the predispersal behavior of this species.

The predispersal behavior of newly-emerged adult female *Ps. columbiae* is not well known. Recently, the behavior of male *Ps. columbiae* in "marker swarms" has been studied in Texas (Peloquin and Olson 1985). Schwardt (1939) reported that adults of this species in Arkansas appeared to spend their early lives very near the larval habitat. The behavior of newly-emerged adults from sites of larval development in Arkansas consists of clinging to emergent vegetation near water level (Horsfall 1942). Mark-recapture studies indicate that *Ps. columbiae* females may migrate up to 14 km from the larval site (Horsfall 1942).

Observations of *Ps. columbiae* in Arkansas suggested that mating takes place in the vicinity of the larval site in the first 18–24 hr after emergence (Horsfall 1955). Provost (1958) reported the only observations of *Ps. columbiae* mating in the field. These observations were made at the periphery of male swarms from 2 broods in November 1954 and October 1955. However, these matings were considered "incidental" by the author. Although the exact location of mating has not been established for *Ps. columbiae*, Provost (1958) concluded that mating occurs over the 2 nights during the peak emergence period. During the nights that mating occurs, male "marker swarms" of various morphologies can be observed (Peloquin and Olson 1985).

Attempts to observe *Ps. columbiae* mating behavior under natural conditions have proven to be difficult because mating in the field occurs during twilight. Also, up until the recent establishment of a free-mating colony of *Ps. columbiae* by Sauerman and Lynn[3], laboratory colonies of this species in the United States have only been maintained by force copulation methods. The only other successful laboratory colonization of a similar species, *Ps. confinnis* (Lynch Arribálzaga), occurred in Colombia, South America, and was maintained for 46 generations (Olano and Morales 1981). No detailed information concerning mating behavior has been reported in the case of either of these colonies.

The purpose of the study described herein was to gain a quantitative insight of postemerg-

[1] This study was conducted in cooperation with the U.S. Department of Agriculture, Agricultural Research Service as part of USDA, CSRS Southern Regional Project S-122 involving State Agricultural Experiment Station personnel located in Arkansas, California, Louisiana, Mississippi and Texas and is approved for publication as TA21737 by the Director of the Texas Agricultural Experiment Station (TAES).

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[3] Reported by D. M. Sauerman and H. Lynn, Florida Medical Entomology Laboratory, IFAS, University of Florida, Vero Beach, FL at the 51st annual meeting of the American Mosquito Control Association, New Orleans, LA (April 20–24, 1986).

ence adult abundance and percent insemination of *Ps. columbiae* near larval sites in eastern Texas riceland areas. Field observations on diurnal and nocturnal behavior of adults were also made.

METHODS AND MATERIALS

Field studies of the postemergence and mating behavior of *Ps. columbiae* were conducted in planted rice fields near Anahuac (Chambers County), TX. During each study period, the rice fields were flooded with either irrigation or rain water. The growing rice extended 15–46 cm above the water surface.

Three separate experiments, each including 4 sampling nights beginning on the night before adult emergence, were conducted during the summers of 1984 and 1985. The sampling nights were designated as premating night, mating night 1, mating night 2 and postmating night. Immature populations in the rice fields were monitored daily by using a 500 ml dipper, taking 100 random dips on or near the water surface. Three quantitative sweep net samples were taken every 30 min from 1900 to 2400 hr each night. Each sample consisted of 20 sweeps through the emergent rice with a standard 30.5 cm diam sweep net. Additional aerial samples were taken of mosquito swarms using the standard sweep net with a 4 m handle. Three replicate samples were taken at 30 min intervals when swarming mosquitoes were observed.

Mosquitoes were anesthetized with carbon dioxide, placed in cardboard collection containers and stored in an ice chest containing dry ice. These samples were used to determine location and temporal abundance of males and females, and percent insemination of females. Insemination of females (maximum of 10/sample) was determined by examining the spermathecae for the presence of sperm under 200x magnification.

Due to the unequal numbers of samples collected, the data were analyzed statistically with the General Linear Models procedure of the Statistical Analysis System (SAS 1985). Mosquito abundance and percent insemination means were compared using Duncan's multiple range test.

RESULTS AND DISCUSSION

Analysis of sweep net samples taken through the emergent rice during the sampling nights indicated no significant difference between the average numbers of males and females collected each night. These data are shown in Table 1 as "Mean Total.*" Significantly more mosquitoes ($p < 0.01$) were collected on the 2 mating nights than either the premating or postmating nights. When comparing the 2 mating nights, there was a significant difference ($p < 0.01$) between the total number of mosquitoes collected between the nights. Most of the mosquitoes emerged later during the premating night or during the following day. This was confirmed by daily dipper sampling of the larval habitat. The lower number of mosquitoes collected during those nights designated mating night 2 and postmating night suggest that both males and females moved out of the sampling area. This is believed to represent the initial dispersal event. Horsfall (1955) reported that male *Ps. columbiae* move with the females during dispersal flight; this has been confirmed for Texas populations (K. L. Flatt, unpublished data).

Table 1. Mean number of male and female *Psorophora columbiae* collected from "sheet swarms" during 1984 and 1985 in Chambers Co. TX.

	Premating		Mating night 1		Mating night 2		Postmating	
Time	M	F	M	F	M	F	M	F
1900	8.0	4.0	34.0	32.0	4.0	3.0	3.0	3.0
1930	7.5	4.5	54.0	74.5	40.5	41.5	7.0	10.0
2000	25.5	16.5	32.6	34.3	23.0	19.0	11.5	8.5
2030	17.5	14.5	49.3	48.0	36.3	40.0	8.0	10.5
2100	11.0	6.0	7.3	17.7	23.3	30.3	6.0	8.5
2130	5.0	7.5	28.3	15.7	7.7	11.0	10.0	9.0
2200	11.5	3.5	20.7	13.0	10.3	7.3	13.0	7.5
2230	10.5	9.5	18.3	9.0	11.0	11.7	6.0	5.0
2300	12.0	10.0	14.3	8.7	4.0	9.7	5.5	4.0
2330	1.0	6.0	9.0	8.0	7.7	7.3	4.5	2.0
2400	3.0	11.0	6.7	9.7	2.0	7.0	4.5	1.5
Mean Total*	112.5	93.0	272.5	270.6	169.8	187.8	80.0	69.5

* Average of the total mosquitoes collected during each study night.

Approximately 45–75 min after official sunset during the 2 mating nights large "ceiling swarms" (Nielsen and Haeger 1960) could be observed 5–10 m above the ground (Fig. 1). These are different from the male "sheet" (ground) and "marker" swarms previously described (Nielsen and Greve 1950, Peloquin and Olson 1985). Mosquitoes collected from the "ceiling swarms" were mostly males (90%). However, both unmated and mated females were collected. The "ceiling swarms" observed in this study appeared as a thick blanket of mosquitoes with a great deal of movement of individuals in the swarm. This "milling around" of the departing migrants is comparable to that of *Aedes taeniorhynchus* (Wied.) (Nielsen and Haeger 1960).

During the periods of swarming, biting activity was fierce and the noise produced by the swarm was relatively loud. At approximately 60–90 min after sunset the swarm dissipated which suggests the initiation of dispersal. This is considered similar to the initial phase of migration described for *Ae. taeniorhynchus* (Nielsen and Nielsen 1953; Provost 1953, 1957). At this time, there was a marked reduction in wing-beat noise and biting activity. Field observations made during 1984 suggest that winds in excess of 16 kph may cause the mosquitoes to remain clinging to the grass, thereby preventing mating and dispersal. These observations support those made by Schwardt (1939).

The mean number of females collected during the premating and postmating nights were low (< 15/sample) and showed temporal constancy (Fig. 2). Significantly greater ($p < 0.01$) numbers of females were collected before 2130 hr on both mating nights. Before 2030 hr (approximately sunset) the females displayed the daytime resting behavior of clinging to rice stems and flying close to the water surface (Horsfall 1942) and thus, were collected in more numbers in the sweep net samples. After 2030 hr the females begin to move up out of the rice, presumably to mate and prepare for dispersal. There was no significant difference in mean abundance of females between any of the nights after 2130 hr. This supports the idea that after mating takes place the females leave the site and do not move back down into the flooded rice plants where they were collected in great numbers from the "sheet swarm" before sunset.

The mean percent insemination of the females was low (< 15%) on the premating nights (Fig. 3). This suggests little mating activity on these nights. During mating nights 1 and 2, the percent insemination increased sharply after 2000 hr (approximately sunset). The mean percent insemination increased to a maximum of 70% on mating night 1 and 100% on mating night 2 at 2300 hr.

The difference in the highest mean percent insemination between these 2 nights was probably due to the presence of newly-emerged females unreceptive to mating during mating night 1. Aquatic dip net samples

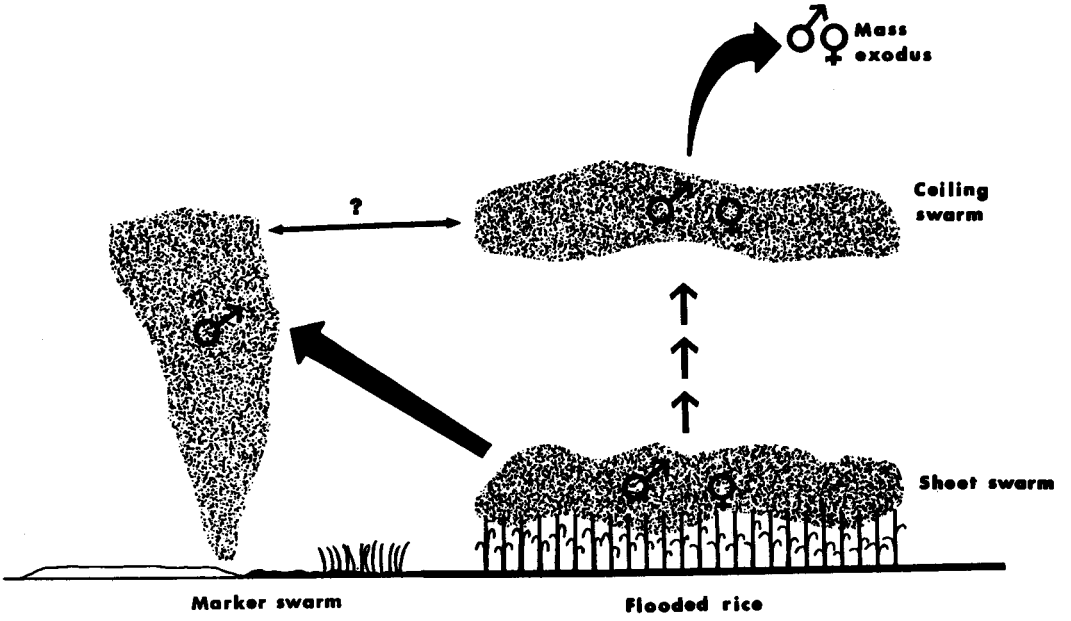

Fig. 1. Diagrammatic representation of adult *Psorophora columbiae* swarming behavior near the larval site before the initial dispersal event.

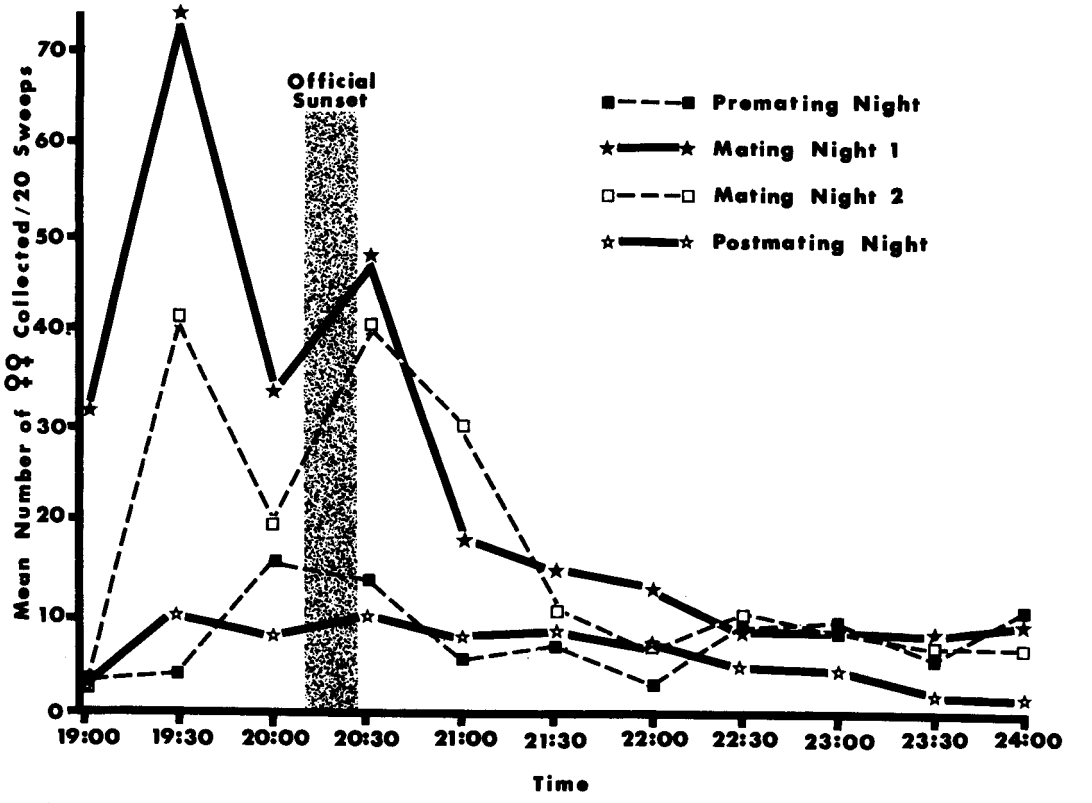

Fig. 2. Mean female *Psorophora columbiae* abundance determined from quantitative sweep net samples taken from "sheet swarms." Three replicate samples were taken at one-half hour intervals during each sampling night, then pooled according to each designated night (premating night, mating night 1, mating night 2 and postmating night).

confirmed that mosquitoes were still emerging during mating night 1. By mating night 2 all the adults had emerged and the females were receptive to mating, thus increasing the maximum percent insemination from the first mating night.

The percent insemination was < 10% before 2000 hr on both mating nights. This indicates that most of the females present before sunset had not mated. This is consistent with the idea that on each night when mating occurs, there is a mass exodus of mated females from the larval habitat. During the postmating nights the percent insemination started out high (100%) and remained relatively constant. This suggests that females collected on these nights were mated on one of the previous two mating nights and did not disperse or they flew in from some other area. The first possibility is consistent with the early belief of Provost (1958) in Florida that mating occurs on the 2 nights during the emergence period. He also reported that most females of a brood are inseminated on their first adult day, which is consistent with our data and field observations.

The postemergence behavior of *Ps. columbiae* females is predictable until the time of migration. Since there are usually 2 nights of mating in a brood, mosquito control personnel have an opportunity to interdict a large, concentrated population before dispersal takes place. This might significantly reduce mosquito populations before they had a chance to disperse from the larval habitat to densely populated urban areas. A rule-of-thumb would be to spray along the upwind side of the larval habitat on the second and third nights (approximately 0-2 hr after official sunset) after late fourth instar and pupae are detected. However, this schedule is subject to changing conditions of flooding of the habitat, rainfall, temperature, and wind. In certain instances, the spray period may need to be extended beyond the suggested 2 nights for adequate control.

ACKNOWLEDGMENTS

The authors wish to thank Matthew M. Yates, formerly the Director of Chambers County Mosquito Control for his help in

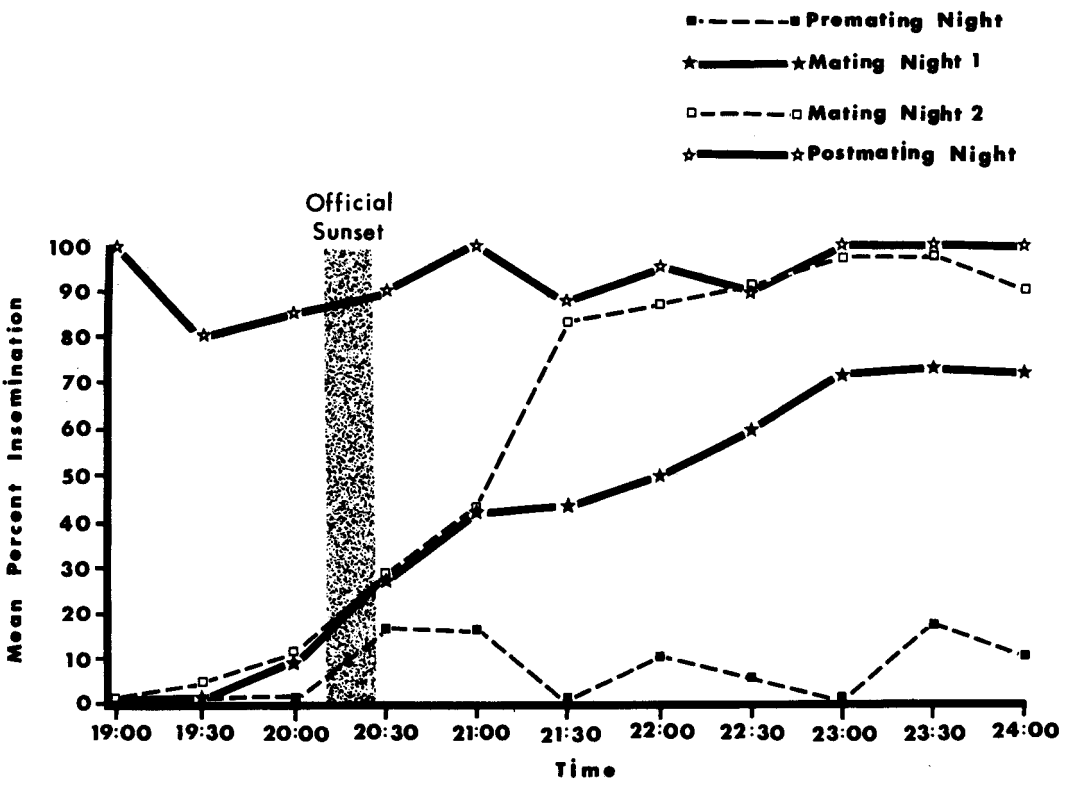

Fig. 3. Mean percent insemination of female *Psorophora columbiae* collected during the designated sampling nights (premating night, mating night 1, mating night 2 and postmating night) determined by dissection of spermathecae of females.

lending facilities, equipment and ideas during this study. Appreciation is also extended to Dong-Kyu Lee, Kyle Flatt, Matthew Hodde and Steven Rankin for their help in the field.

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