OCCURRENCE OF *PSOROPHORA COLUMBIAE* EGGS IN DIFFERENT FIELD TYPES COMPRISING A TEXAS RICELAND AGROECOSYSTEM[1]

J. B. WELCH,[2] J. K. OLSON[3] AND M. M. YATES[4]

ABSTRACT. Soil samples (3,258) were collected from soybean fields, rice fields and permanent pastures in Chambers County, TX over a 2½-year period and examined for the presence of *Psorophora columbiae* eggs. Eggs occurred more frequently and in greater numbers in samples taken from soybean fields than in samples from either rice fields or permanent pastures during the summers of 1979 and 1981 when there was heavy rainfall in the study area. Under dry conditions, as during the summer of 1980, the frequency of egg occurrence and abundance increased in samples taken from rice fields. However, egg occurrence and abundance in soybean field samples still remained relatively high even during this particular year.

INTRODUCTION

Psorophora columbiae (Dyar and Knab) is a major pest of man and livestock in rice-growing areas along the Texas Gulf Coast as well as in other parts of the southern rice-producing region of the United States. This mosquito is a temporary pool or floodwater species which deposits its eggs in or on soil subject to temporary inundation (Horsfall 1955). Females oviposit in a variety of microhabitats in riceland agroecosystems (Schwardt 1939; Horsfall 1942, 1955; Meek and Olson 1976) and soil moisture content is a major factor affecting the selection of a particular site by *Ps. columbiae* for oviposition (Olson and Meek 1977).

Soil moisture also appears to be an important factor in *Ps. columbiae* egg survival. Eggs of this species are susceptible to desiccation (Schwardt 1939, Barr and Al-Asawi 1958), but under favorable conditions eggs deposited in the fall can remain viable throughout the winter (Olson and Meek 1979).

We studied oviposition patterns of *Ps. columbiae* over a 2½-year period in a Texas riceland agroecosystem which included soybeans in the crop rotation scheme. Egg populations were monitored in soybean fields, rice fields and pastured fields to determine the relative importance of these different field types as oviposition sites for *Ps. columbiae*.

MATERIALS AND METHODS

The fields used were located in Chambers County, TX. The first 3 fields selected in May 1979 were east of the Old River in a Beaumont-Morey-Lake Charles soil association. This association is characterized as level or nearly level, acid to neutral, clayey and loamy soils with very slow permeability, which allows water to stand for long periods after heavy rainfall (Crout 1976).

One study field (70.8 ha) was planted in rice during the summer of 1979 and again during 1980 and was subsequently planted in soybeans during the summer of 1981. This field will be referred to hereafter as Field 1-Rice or Field 1-Soybean, depending on the crop. The second field was located immediately north of Field 1. This 33.8 ha field was planted in soybeans and then to rice during the growing seasons of 1979 and 1980, respectively and will be referred to as either Field 2-Soybean or Field 2-Rice. The third field (Field 3-Permanent Pasture) was a 10.4 ha pasture located approximately 1.6 km north of Field 2.

Three more fields were added to the study during June 1980. One was located in a Beaumont-Morey-Lake Charles soil association approximately 3.2 km southwest of Field 1. This 18.5 ha field was designated Field 5-Soybean since it was planted in soybeans during 1980. The other 2 new fields were located 24.8 km southeast of the other sites in a Vaiden-Acadia-Calhoun Soil association characterized as being nearly level with slightly depressed areas where water stands for long periods after heavy rains (Crout 1976). One of these fields (32.2 ha) was planted in soybeans in 1980. The other was a 14.9 ha permanent pasture. These fields will be referred to as Field 4-Soybean and Field 6-Permanent Pasture, respectively.

Two additional fields were selected during the summer of 1981. These fields were located in the Beaumont-Morey-Lake Charles soil association in the vicinity of Fields 1–3 and 5. One of these fields (6.4 ha) was planted in rice and

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[2] Present address: USDA, ARS Screwworm Research, American Embassy, APO Miami, 34020.

[3] Department of Entomology, Texas A&M University, College Station, TX 77843.

[4] East Baton Rouge Mosquito Abatement and Rodent Control District, P. O. Box 1471, Baton Rouge, LA 70821.

will be referred to as Field 7-Rice. The other field (49.7 ha) was planted in soybeans and will be referred to as Field 8-Soybean.

Over the 2½-year study period (June 1979–September 1981), 3,258 soil samples (15.2 × 15.2 × 2.5 cm each) were taken from the various study fields using techniques described by Horsfall (1956). Soil moisture content was estimated at the time of sampling by the hand-squeeze technique of Box and Bennett (1959) as adapted for mosquito studies by Olson and Meek (1977). Each sample was placed in a plastic bag, collection data were printed on the bag and all bagged samples were transported to the Mosquito Research Laboratory at Texas A&M University, College Station, TX for separation.

Samples were collected from sites in Field 1 on a weekly basis from June 5, 1979 through April 28, 1981 and on June 24, 25 and September 23, 1981. Samples were collected in Field 2 on a weekly basis from June 26, 1979 through April 28, 1981. Weekly soil samples were collected in Field 3 from June 19, 1979 through April 28, 1981. Collections of soil samples from sites in Fields 4–6 were taken on a weekly basis from June 4, 1980 through April 28, 1981. Soil samples were collected from sites in Field 7 on June 24 and September 23 and from Field 8 on September 23, 1981.

Each soil sample was collected from a specific microhabitat in the sampling area of a given field that was known or suspected to be attractive to *Ps. columbiae* for oviposition. For example, samples were collected from the 75–100% soil moisture zones along rice field levees (Meek and Olson 1976, Olson and Meek 1980) and from vehicle tire tracks and cattle hoof prints at various locations in permanent pastures (Meek and Olson 1977). In the case of soybean fields, it was not known where mosquitoes might deposit their eggs since this crop was a relatively new component of the Texas riceland agroecosystem in 1979. Thus, soil samples were taken from sites in these fields which were either natural depressions where periodic ground pools of water formed after rainfall or vehicle tire tracks.

Soil samples were processed at the laboratory using the egg separator and salt water flotation procedures of Horsfall (1956) as modified by Meek[5] and Welch.[6] Tests of the procedures used in this study were conducted by processing soil samples into which known numbers of mosquito eggs were placed. Results indicated an egg retrieval accuracy of 90–100%.

Mosquito eggs were counted and identified to species using a dissecting stereomiscroscope and taxonomic keys (Ross and Horsfall 1965). Unidentifiable eggs were hatched and larvae reared to the fourth instar were identified and counted.

Chi-square statistical analyses were performed using soil sample egg collection data to determine patterns of oviposition by *Ps. columbiae*. The null hypothesis tested was: oviposition in rice fields = oviposition in soybean fields = oviposition in permanent pastures. The alternative hypothesis was: at least one of the observed counts was different from the hypothesized value. In other words, oviposition among fields was equal or a preference was observed where oviposition occurred more frequently or less frequently in one type of field as compared to the others.

Adult mosquito populations were monitored to confirm the presence of *Ps. columbiae* females in the study areas. Body landing rate counts were conducted weekly from June 20 to October 7, 1980 and June 2 to September 22, 1981. Sampling with CDC miniature light traps (Sudia and Chamberlain 1962) was conducted weekly from August 11 to September 1980 and June 8 to September 14, 1981. Sampling of adult mosquitoes using both techniques was performed in Fields 1–6 during 1980 and in Fields 1 and 7 during 1981.

Monthly rainfall data recorded at a NOAA station in the middle of the study area (Trinity Bay Soil and Water Conservation District, Anahuac, TX) were obtained to determine the general precipitation patterns occurring over the study period. These data were gathered from June 1, 1979 through September 23, 1981.

RESULTS

Psorophora columbiae eggs occurred more frequently and at higher numbers in soil samples taken from the soybean field from June 1979 through March 1980 than in samples collected from either the rice field or the pasture (Fig. 1). Chi-square analysis of these data indicated a highly significant difference ($p < 0.005$) between the soybean field and the other 2 field types with a higher abundance of eggs and a greater frequency of egg occurrence being recorded for the soybean field.

[5] Meek, C. L. 1975. Bionomics of *Psorophora confinnis* (Lynch-Arribálzaga) in Texas ricelands. Oviposition sites and egg longevity. Ph.D. dissertation, Texas A&M Univ., College Station, TX. 199 pp.

[6] Welch, J. B. 1983. The use of aerial color infrared photography as a survey technique for oviposition sites of *Psorophora columbiae* (Dyar and Knab) (Diptera: Culicidae) in a Texas riceland agroecosystem. Ph.D. dissertation, Texas A&M Univ., College Station, TX 227 pp.

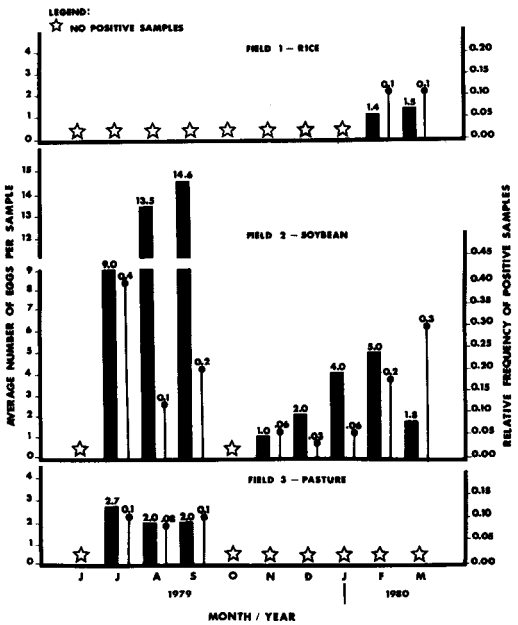

Fig. 1. Monthly average numbers and relative frequencies of *Psorophora columbiae* eggs occurring in soil samples collected June 1979—March 1980 from rice field, soybean field and permanent pasture sites in Chambers County, TX.

Soil sampling results for the second season (April 1980–April 1981) of the study are summarized in Fig. 2 for rice fields and one pasture and in Fig. 3 for the soybean fields and the other pasture. Eggs occurred more frequently in samples taken from the rice field and pasture sites than was the case in the previous season. Chi-square analysis of these data indicated no significant difference among any of the 3 types of fields as far as the relative frequency of egg-positive samples was concerned. However, the difference in the average number of eggs per sample was highly significant ($p < 0.005$) among fields. Higher than expected numbers of eggs were collected from the 2 soybean fields (Fig. 3) and Field 3-Permanent Pasture (Fig. 2). Fewer eggs per sample were collected from both of the rice fields (Fig. 2) and Field 6-Permanent Pasture (Fig. 3) than would be expected if the rate of egg deposition by *Ps. columbiae* females had been equal for all fields.

Results of the soil sampling effort conducted during June–September 1981 are summarized in Fig. 4. Chi-square analysis of these data indicated that during June 1981 a significantly higher frequency of positive samples ($p < 0.05$) was observed in samples from Field 1-Soybean compared to Field 7-Rice. Also, the difference in the numbers of eggs occurring in samples was highly significant ($p < 0.01$) with more eggs occurring in samples from the soybean field during June. The difference between the relative frequency of positive samples of the 2 fields planted to soybeans and Field 7-Rice was not significant during September. However, a highly significant difference ($p < 0.005$) was observed in the abundance of eggs among these fields with the majority of eggs being collected from Field 8-Soybean.

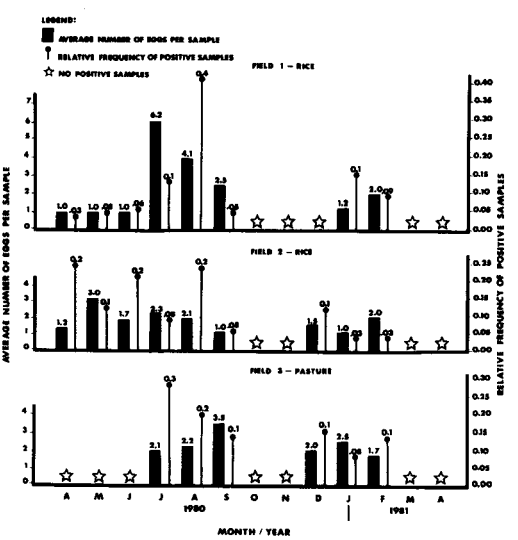

Fig. 2. Monthly average numbers and relative frequencies of *Psorophora columbiae* eggs occurring in soil samples collected April 1980—April 1981 in 2 rice fields and a permanent pasture in Chambers County, TX.

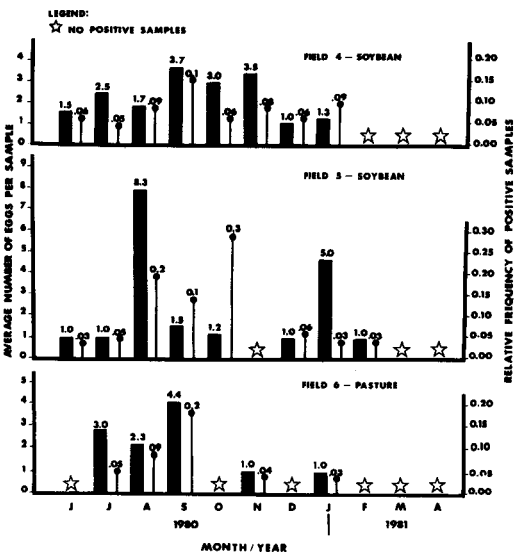

Fig. 3. Monthly average numbers and relative frequencies of *Psorophora columbiae* eggs occurring in soil samples collected June 1980—April 1981 in 2 soybean fields and a permanent pasture in Chambers County, TX.

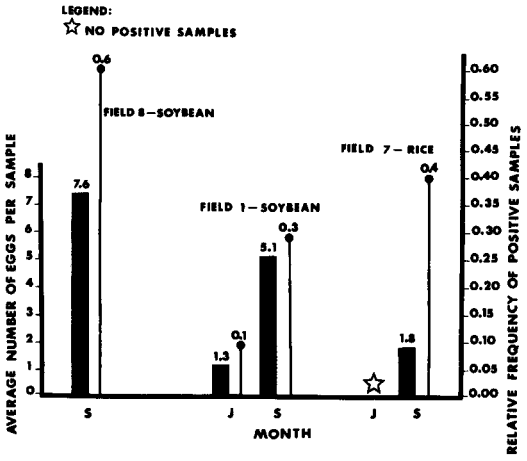

Fig. 4. Monthly average numbers and relative frequencies of *Psorophora columbiae* eggs occurring in soil samples collected during June and September 1981 from 2 soybean fields and a rice field in Chambers County TX.

Landing rate counts during 1980 and 1981 confirmed *Ps. columbiae* females to be present periodically in each of the study fields. Early summer populations of *Ps. columbiae* peaked during June 17–24, 1980 and during June 2–9, 1981. Highest landing rate counts for each of these early summer populations was 201 females/min and 10 females/min, respectively. Fall populations of *Ps. columbiae* peaked during September 16–30, 1980 and during September 1–15, 1981. Landing rates for each of these periods were 20 females/min and 10 females/min, respectively.

Light trap collections also recorded the presence of *Ps. columbiae* females in the vicinity of the study fields during 1980 and 1981. Other female mosquito species found in the light trap collections were: *Aedes sollicitans* (Walker), *Anopheles crucians* Wiedemann, *An. quadrimaculatus* Say, *Coquillettidia perturbans* (Walker), *Culex salinarius* Coquillett and *Psorophora ciliata* (Fabricius) during 1980 and *Ae. sollicitans, Ae. taeniorhynchus* (Wiedemann), *Ae. vexans* (Meigen), *An. quadrimaculatus, Cx. salinarius* and *Ps. ciliata* during 1981.

Monthly total rainfall records from June 1, 1979–September 23, 1981 are presented in Fig. 5. Total precipitation during the common period of peak adult mosquito activity (i.e., June–September) was 729.0 mm for 1979, 505.5 mm for 1980 and 950.0 mm for 1981. The average rainfall for Chambers County is ca. 480 mm. Therefore, the summers of 1979 and 1981 were definitely wetter than normal, while the summer of 1980 was more typical with little or no rainfall occurring until September.

DISCUSSION

Results of our study indicate soybean fields are frequently used for egg deposition by *Ps.*

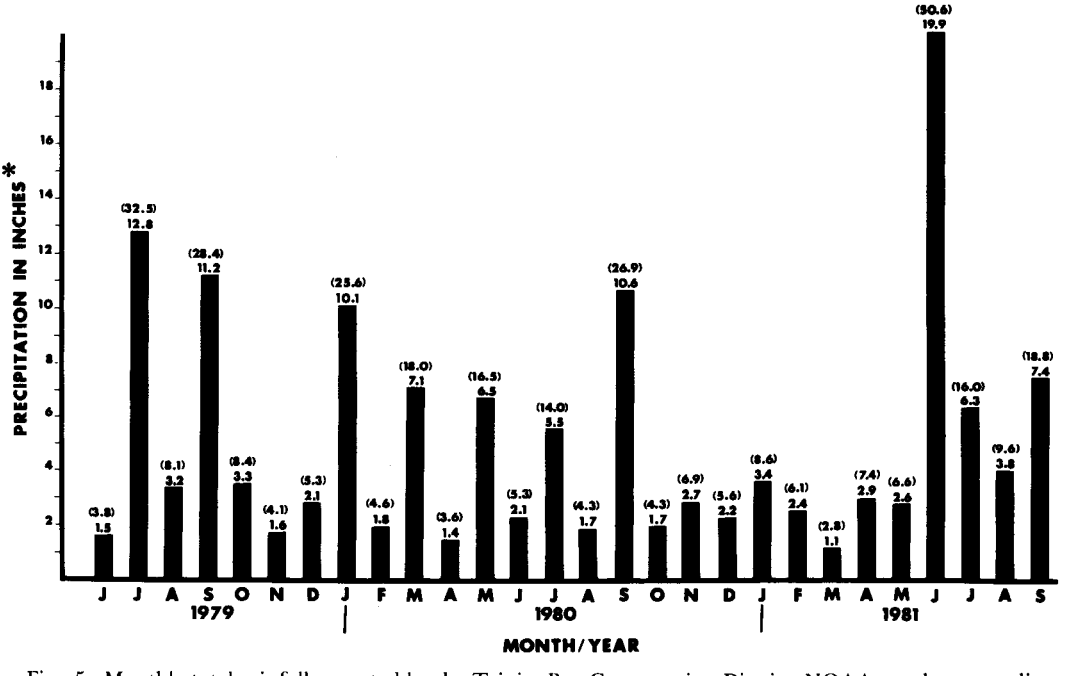

Fig. 5. Monthly total rainfall reported by the Trinity Bay Conservation District, NOAA weather recording station in Anahuac, Chambers County, TX, during June 1, 1979–September 23, 1981. (*) Rainfall in cm shown in parentheses.

columbiae in Texas ricelands. In earlier studies, Horsfall (1942) reported soybean fields to be unlikely oviposition sites for *Ps. columbiae* under Arkansas conditions. The degree to which *Ps. columbiae* will deposit eggs in soybean fields as opposed to other field types in Texas riceland systems appears to be particularly influenced by precipitation patterns occurring during the period when adult mosquitoes are active.

The changing relationship in patterns of oviposition by *Ps. columbiae* between different field components of a Texas riceland system from year to year is exemplified by the data gathered during this study. Fields planted in soybeans were distinctly favored by this species as oviposition sites over rice and pastured fields during the relatively wet summers of 1979 and 1981 (Figs. 1, 4, 5). The preference of *Ps. columbiae* for different types of fields became less clear during the conditions of little or no rainfall that occurred during 1980 (Figs. 2, 3, 5). In this latter case, soybean fields appeared to remain an important source of oviposition sites for *Ps. columbiae;* but, pastures and particularly rice fields became more important in this regard. The increased use of flooded rice fields as sources of oviposition sites by *Ps. columbiae* during relatively dry years reinforces previous findings (Meek and Olson 1976). The importance of rice fields as oviposition habitats is greater during summer months with little or no rainfall probably because the soak zone areas of the levees of flooded fields provides an oviposition substrate consistently having the preferred soil moisture content range of 75–100% field capacity.

On the basis of this study, it appears that the current agronomic practice of rotating soybeans with rice has added another important source of oviposition sites for *Ps. columbiae* populations breeding in Texas riceland agroecosystems. The results reported herein indicate that mosquito control practitioners should pay as much attention in their monitoring programs to soybean fields as potential sources of *Ps. columbiae* breeding sites as they do to other types of fields occurring in southern rice-growing areas. This is particularly true when the soybean fields are on poorly drained, heavy clay-type soils such as occur in the rice-growing regions of the upper gulf coast of Texas and Louisiana.

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