OVIPOSITION SITES USED BY *PSOROPHORA COLUMBIAE* (DIPTERA: CULICIDAE) [1] IN TEXAS RICELANDS [2]

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ABSTRACT. Females of *Psorophora columbiae* (Dyar and Knab) deposit their eggs in a variety of microhabitats that exist in the Texas riceland environment. These microhabitats include ones associated with: (1) rice field and pasture levee slopes and lands; (2) cattle hoofprints in fallow rice fields used as pastures; and (3) various types of tire tracks that are made in the soil by harvesting equipment.

INTRODUCTION. Approximately 1.5 million acres of land in the northern third of the Texas coastal zone are used for rice production (Anon. 1974). One-third of this land is planted in rice each year while most of the remainder is used as pasture. Olson and Newton (1973) reported that one of the most important mosquito species breeding in Texas rice fields and associated pastures is *Psorophora columbiae* (Dyar and Knab). The degree to which *P. columbiae* utilizes each of these two environments as breeding habitats throughout the year has not been documented for Texas.

Horsfall (1942) indicated that, in the spring, riceland fields over which livestock had grazed during the previous season supported very high larval populations of *P. columbiae* in Arkansas. Texas mosquito control district personnel have indicated that they suspect pastures also serve as important oviposition sites for this species in Texas ricelands. However, supporting data are lacking. Also, data reflecting egg deposition patterns for *P. columbiae* in general are meager, particularly in relation to the timing of oviposition and placement of eggs in riceland habitats (Horsfall 1955). The research reported herein offers some insight on the relative importance of pastures and rice fields as oviposition sites for *P. columbiae* in Texas.

METHODS AND MATERIALS. Field studies of the oviposition behavior of *P. columbiae* in both rice-growing and pasture land environments were conducted on the J. T. Garrett Ranch near Danbury, Brazoria County, Texas. Productive rice fields on this ranch were typical of the rice culture systems in the northeastern portion of the Texas coastal zone. Each field was subdivided by the farmer into several subunits hereafter referred to as *pans*. Each pan was comprised of a flat plateau, referred to hereafter as a *land*. The land was bordered on all sides by raised earthen dikes, referred to hereafter as *levees*. Pastures generally had the same topographical features as rice fields since the former were fallow rice fields. A number of man- and animal-made terrain features in rice fields and associated pastures were suspected of having physical factors which induced egg deposition by *P. columbiae,* namely: levee slopes, lands, cattle hoofprints and tire tracks of harvesting machinery. Locating and assessing the relative importance of these suspected oviposition sites were accomplished by periodically collecting soil samples from individual rice fields and pastures over a 2-year period and subjecting the samples to the methods of floodwater mosquito egg separtion described by Horsfall (1956).

Two rice fields were sampled for mosquito eggs during the course of the 2-year

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[1] *Psorophora columbiae* (Dyar and Knab) = *P. confinnis* (Lynch-Arribálzaga) (Belkin et al. 1970).

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study. One field was placed into rice production during 1973, and the other was planted in rice in 1974. Soil samples were taken from designated land and levee sites within each of 3 pans in the 1973 rice field and each of 2 pans in the 1974 rice field.

Two pastured fields were also studied. One pasture had been planted in rice during 1972 (or the year prior to the beginning of the study) and was sampled continuously for 2 years (1973–74). The other pasture was the rice field used in our study during 1973. Soil samples were removed from designated land and levee sites within 3 pans in each of the 2 pastures.

Soil samples were taken from each sampling site within a given field using a modification of techniques described by Horsfall (1956). Levee soil samples consisted of 6 x 6 x 1 in. squares of soil cut sequentially with the aid of a mortar trowel from a 6 in. wide strip of soil extending from the top to the bottom of a given levee slope that faced into the pan. Each sample was placed in a separate plastic bag which was labeled as to location and date of sampling. The same techniques were used in taking soil samples from sites on the lands of each study pan.

Samples of cattle hoofprints occurring in the pastured fields were taken along imaginary lines extending across the land from the top levee to the bottom levee of each study pan in a given pasture. The soil within each sampled hoofprint was totally removed with the aid of a mortar trowel. The inner surface area of a hoofprint was approximately equal to the surface area of soil encompassed to two 6 x 6 in. soil sample squares taken from levees and lands. Each hoofprint sample was placed in a separate plastic bag and labeled with the approprite collection information for processing. An attempt was made to sample only those hoofprints that exhibited: (1) a depth of 3 in. or more; (2) no standing water in the bottom of the hoofprint; and (3) some type of vegetative cover.

Soil samples taken from harvest equipment tracks in harvested rice fields were also removed along an imaginary line extending between the upper and lower levees of a given pan. There were 2 types of tracks: (1) smooth-sided tire tracks caused by the steering wheel tires of the combines and tractors and (2) cleated tire tracks caused by the cleated drive wheels of the combines and tractors and the wheels of grain carts.

The smooth tracks were sampled by dividing each track longitudinally along its bottom center for a distance of 6 in. using a mortar trowel. Subsequently, a 6 x 6 x 1 soil square was removed from the smooth track on either side of the dividing line. Cleat tracks, each of which measured approximately 19 in. long, 3 in. wide and 3.5 in. deep, were removed in their entirety from the land. The surface area of soil included in a given cleat track sample was approximtely equal to five 6 x 6 in. levee soil sample squares. Each track sample was placed in a separate plastic bag labeled with appropriate field collection information.

When possible, soil samples were taken from all sites within the study fields on the following schedule: (1) prior to the first of several temporary flushings of rice with irrigation water which occurred in the early spring; (2) during the 60-day permanent flood period which occurred from July-August; (3) following final drainage and subsequent harvest in August or September; and (4) during late winter to assess the abundance and distribution of the overwintering egg population (February).

All soil samples were brought to our laboratories in College Station, Texas, for processing. An egg separating device similar to the one described by Horsfall (1956) was used to initially separate mosquito eggs from each soil sample. The portion of the soil residues from the egg separating device which theoretically contained the mosquito eggs from a given soil sample was subjected to a salt flotation process in the manner described by Horsfall (1956). The eggs retrieved from each soil sample were placed on moist filter paper pads, counted and identified to species using a

Table 1. Relative abundance of *Psorophora columbiae* eggs present in levee and land soil samples taken from rice fields and pastures in Brazoria County, Texas during May, 1937–September, 1974.

Sampling Date	Ave. No. of eggs/36 sq. in. soil surface[a] taken from					
	Rice field		2-Year Pasture[b]		1-Year Pasture[c]	
	Levees	Lands	Levees	Lands	Levees	Lands
1973						
15–22 May	2.6 (1–11)	4.2 (2–13)	5.7 (1–28)	–	–	–
15 Jul	12.4 (1–102)	Flooded	36.2 (5–147)	1.0 (1)	–	–
22 Sep	6.1 (1–52)	5.3 (1–20)	4.6 (1–14)	3.7 (1–10)	–	–
1974						
5 Feb	–	–	8.0 (1–21)	–	20.1 (1–138)	–
17 May	12.3 (1–61)	1.3 (1–2)	4.7 (1–11)	–	5.3 (1–21)	–
4 Jul	27.5 (1–112)	Flooded	1.0 (1)	–	14.9 (1–74)	–
21 Sep	25.3 (1–109)	5.1 (1–15)	8.4 (1–22)	–	20.0 (1–200)	–

[a] Averages are based on only those soil samples that contained *P. columbiae* eggs. Ranges in the number of eggs per sample are given in parentheses.
[b] The "2-year pasture" was in rice the year prior to the initiation of the study.
[c] The "1-year pasture" was the 1973 rice field used in the study.

stereomicroscope and taxonomic keys developed by Horsfall et al. (1952) and Ross and Horsfall (1965). In cases when eggs could not be identified, they were hatched, and the larvae were reared to the fourth instar and then identified. The number of eggs per mosquito species per soil sample was recorded by date and soil sample number. For purposes of comparison, the average numbers of eggs per sample from each habitat were computed on the basis of the surface area of the 6 x 6 levee samples (i.e., eggs per 36 sq. in. of soil surface). The results described herein are based on a total of 425 levee samples, 151 land samples, 80 smooth tire track samples, 18 cleated tire track samples (=ninety 36 sq. in. samples), and 123 hoofprint samples (= two hundred forty-six 36 sq. in. samples).

RESULTS AND DISCUSSION. Eggs of *P. columbiae* were found in each microhabitat that we sampled in the Texas riceland ecosystem. These microhabitats included ones associated with: (1) rice field and pasture levees and lands (Table 1); (2) cattle hoofprints in fallow rice fields that were used as pastures (Table 2); and tire tracks made in the soil by rice harvesting equipment (Table 3). The data presented in each table are based only on soil samples which contained eggs. The presence of a minimum of one *P. columbiae* egg in a given sample indicated to us that conditions at the site from which the sample was taken had been attractive to gravid female mosquitoes for at least a period of time prior to our sampling. Therefore, by using only the samples that contained eggs, we were better able to assess the relative degree to which females of *P. columbiae* used each type of site for egg deposition during times when conditions in each site were attractive to female mosquitoes seeking oviposition sites.

The level portions of lands within both rice fields and associated pastures appear to be the least important as potential ovi-

Table 2. Relative abundance of *Psorophora columbiae* eggs in cattle hoofprint soil samples taken on lands of study pastures in Brazoria County, Texas, during May, 1973–September, 1974.

Sampling Date	Ave. No. of eggs/36 sq. in. soil surface[a] taken from cattle hoofprints in: 2-Year Pasture[b]	1-Year Pasture[c]
1973		
11 May	7.9 (1–61)	
15 Jul	12.4 (1–106)	
29 Sep	4.0 (1–89)	
1974		
12 Feb	4.5 (1–35)	15.5 (1–162)
17 May	–	2.6 (1–16)
4 Jul	5.0 (2–21)	19.4 (5–87)
28 Sep	Not Present	3.3 (6–7)

[a] Equal to area of individual levee and land soil samples (i.e., the the area of 2 levee or land soil samples = the area of 1 hoofprint). Averages are based on only those hoofprint samples that contained eggs and the numbers in parentheses represent the range of eggs present in individual hoofprint samples.

[b] The "2-year" pasture was in rice the year prior to the initiation of the study.

[c] The "1-year" pasture was the 1973 rice field used in the study.

Table 3. Relative abundance of *Psorophora columbiae* eggs in tire track soil samples taken in harvested rice fields in Brazoria County, Texas, during October, 1973–September, 1974.

Sampling Date	Ave. No. of eggs/36 sq. in. soil surface[a] taken from: Smooth Tire Tracks	Cleated Tire Tracks
1973	HARVESTED 1973	RICE FIELD
9 Oct	39.3 (1–256)	1.4 (1–12)
1974		
5 Feb	34.3 (1–134)	6.1 (2–105)
17 May	10.3 (1–23)	Not present
4 Jul	1.6 (1–3)	Not present
	HARVESTED 1974	RICE FIELD
21 Sep	18.3 (1–86)	1.7 (1–22)

[a] Equal to the area encompassed by individual levee and land samples (i.e., the area of 1 smooth tire track sample = the area of 1 land or levee sample and the area of 1 cleated tire track = the area of 5 land or levee samples). Averages are based only on those samples that contained eggs and the numbers in parentheses represent the range of eggs present in individual tire track samples.

position sites for *P. columbiae* (Table 1). Although females of this species will deposit small numbers of eggs on the flatter portions of lands, they appear to be more commonly attracted to deep depressions in lands. On the basis of the results of our studies, tire tracks, particularly the deep, smooth tire tracks of combine and tractor steering wheel tires (Table 3), and hoofprints of cattle (Table 2) are among the most attractive types of depressions that occur in lands. Data gathered during the late fall and winter months indicate that smooth tire tracks and hoofprints along with levees in recently harvested rice fields cause these particular fields to be important sources of oviposition sites for fall populations of *P. columbiae* (Tables 3, 2 and 1 respectively). Horsfall (1955) stated that Arkansas populations of *P. columbiae* utilized newly harvested rice fields very little for oviposition. In contrast, we feel that, on the basis of the observed densities of late fall and winter egg populations found in the habitats sampled, recently harvested rice fields are used extensively as deposition sites for overwintering eggs of *P. columbiae* breeding in Texas rice lands.

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