EFFECTS OF CATTLE DENSITY ON NEW JERSEY LIGHT TRAP MOSQUITO CAPTURES IN THE RICE/CATTLE AGROECOSYSTEM OF SOUTHWESTERN LOUISIANA[1]

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ABSTRACT. Cattle are the primary host for the major pest mosquito *Psorophora columbiae* in the rice production region of the Gulf-south. Annual captures of *Ps. columbiae*, *Anopheles crucians* and *An. quadrimaculatus* in New Jersey light traps in Acadia Parish in 1984 were correlated with cattle density within 0.8 km of the trap (R^2 = 97, 68 and 74%, respectively). Furthermore, 7 of 10 mosquito species commonly trapped were significantly correlated with cattle density (average R^2 = 82%). This work documents host abundance as a key factor in the population dynamics and distribution of most of the important riceland mosquitoes.

INTRODUCTION

Extensive monoculture of rice in the south central United States of Arkansas, Louisiana, Mississippi and Texas provides vast habitats for development of mosquito populations. The major pest mosquito species of man and his domestic animals in this region are *Psorophora columbiae* (Dyar and Knab), *Anopheles crucians* Wiedemann and *An. quadrimaculatus* Say. Kuntz et al. (1982) identified large domestic animals as the primary hosts for *Ps. columbiae* in Texas ricelands. Although *Ps. columbiae* populations develop without the nearby presence of cattle, the size of the population is directly influenced by the ready availability of large domestic animals (Al-Azawi and Chew 1959, Focks et al. 1988). Moreover, egg densities (Meek and Olson 1977) and larval densities (McLaughlin and Vidrine 1987) are significantly related to cattle density. Focks et al. (1988) defined a conversion factor that relates the numbers of *Ps. columbiae* adults in New Jersey light traps to the absolute densities of adult mosquitoes in nearby areas.

Although the New Jersey light trap is a common surveillance tool for mosquito abatement operations, captures are highly variable. Bidlingmayer (1985) documented the effects of meteorological factors influencing trap captures and also showed that the physiologic state of mosquitoes influences captures. This paper quantifies the functional relationship between cattle density and captures in New Jersey light traps of the 3 major mosquito pests in the riceland agroecosystem of the Gulf-south region of the United States. We believe that improved comprehension of the impact of host density upon mosquito captures in light traps will improve the usefulness of light trap information in daily mosquito abatement actions and in integrated mosquito management control programs.

[1] Mention of a commercial or proprietary product in this paper does not constitute an endorsement of this product by the United States Department of Agriculture.

MATERIALS AND METHODS

New Jersey light trap capture data for *Ps. columbiae*, *An. crucians* and *An. quadrimaculatus* from Acadia and Jefferson Davis parishes in southwestern Louisiana form the basis of this paper. Only Jefferson Davis Parish has an organized mosquito abatement program. Acadia Parish lies adjacent to the east and has similar agricultural, geologic and hydrologic characteristics. Seven light traps were operated in Acadia Parish (363 trap nights) and 11 light traps were operated in Jefferson Davis Parish (530 trap nights) at least twice weekly from April through October 1984. An average nightly capture for the year was calculated for each species encountered for each trap. Night-to-night trap captures often vary by an order of 4 logs (base 10). The cause is a result of a complex of factors that include the episodic nature of adult population densities in response to convection showers and irrigation practices that are highly localized and not synchronized across the area containing all the traps. An annual overall average for a specific location is the only way that effects due to individual factors can be identified against the background of extreme variation. Our intent in this study was to show that cattle do influence the overall population in the immediate vicinity of the trap and not to use that relationship to predict trap captures at any single point in time during the season, because so many other factors affect trap captures both spatially and temporally. Prediction of daily or weekly adult densities requires integration of all factors influencing the population, as is done in PcSim (Focks and McLaughlin 1988).

The location and density of cattle and light trap locations were plotted on United States

Geological Survey aerial photographs of the study site. We calculated the numbers of cattle per hectare in 5 concentric annuli about each trap location, using radii of 0.8, 1.6, 2.4, 3.2 and 4.8 km. Observations throughout the mosquito season confirmed that cattle densities within these annuli remained essentially stable, although some movement of cattle between pastures occurred to manage forage consumption. Spatial distribution of cattle could influence the impact upon trap captures—consider the extreme cases of totally evenly distributed cattle versus the case where all the cattle were in one large herd and thus providing ample source for blood at one direction from the trap but no hosts elsewhere in the annulus under consideration.

The connection between cattle density and average annual light trap counts was determined using a stepwise regression procedure (Proc REG, SAS Institute 1985). Separate analyses were done for each mosquito species and each parish. Independent variables were cattle densities within each of the 5 annuli, and the number of times adulticidal sprays were applied around the traps during the season. Adulticidal sprays are applied on the basis of light trap captures, human landing rate data and citizen complaints, resulting in sprays before, during and after light trap operations. However, the possibility existed that such sprays could modify the capture rates in comparison to those in Acadia Parish. We used stepwise selection with variables added to the model at $P = 0.15$.

RESULTS AND DISCUSSION

Mean cattle densities within annuli of increasing radii from light traps are given in Table 1. The range of densities among the traps within each parish and the standard error of the mean show the diverse conditions in the study area. Note that some traps had no cattle within some of the annuli.

The mean annual number of mosquitoes per trap night for each species and the frequency of occurrence of each species in collections is listed in Table 2. Overall, *Ps. columbiae* was the most abundant species in both parishes; averaging 1,063 per night, it was present in an average of 95% of all collections. *Culex salinarius/erraticus* and *An. crucians* were similar in abundance (306 and 385, respectively) and frequency (79% and 69%). The 4th most frequently caught mosquito (41%) was *An. quadrimaculatus*, averaging 159 per trap night. The other species captured occurred at about 1 or 2 orders of magnitude less frequently and with correspondingly lower numbers. In general, the frequency and number of captures were lower in Jefferson Davis Parish.

The results of regressions of light trap captures on cattle density are presented in Table 3 for Acadia and Jefferson Davis parishes. The tables contain coefficients for linear equations which provide estimates of average, annual captures (expected $\text{captures}_{species}$) at a light trap. For $_{Ps.\ columbiae}$ in Acadia Parish, the equation is:

$$\text{Expected captures}_{Ps.\ columbiae} = 312.3 + 4{,}240.1 \times HD_{0.8\ -\ km}\ (R^2 = 97\%)$$

The coefficients for cattle density for the other radii ($HD_{1.6}, \ldots, HD_{4.8}$) were not included in this particular equation because they were statistically insignificant. Because of low capture frequencies, species occurring less often than *An. quadrimaculatus* are not included in Table 3. The amount of variability in mosquito captures which could be explained by reference to only cattle density was surprising to us. The data from Acadia were not influenced by mosquito control. Here an average of 82% of the variability in 7 of the 10 species listed in Table 2 can be explained by cattle density. Ninety-seven percent of variation in *Ps. columbiae* captures is attributable to cattle density, 68% for *An. crucians* and 74% for *An. quadrimaculatus*. There was not a significant relationship between the combined numbers of *Cx. salinarius* Coq. and *Cx. erraticus* (Dyar and Knab), perhaps reflecting their broad host range of birds, domestic animals and man.

Table 1. Average number of cattle per hectare within annuli with increasing radii from the center of New Jersey light traps[1] in 2 parishes in southwestern Louisiana during 1984.

Distance from traps (km)	Acadia Parish			Jefferson Davis Parish		
	Mean	SE	Range	Mean	SE	Range
0.8	0.24	0.11	0.00–0.73	0.14	0.08	0.00–0.86
1.6	0.14	0.03	0.04–0.24	0.10	0.02	0.00–0.22
2.4	0.08	0.02	0.03–0.14	0.06	0.01	0.01–0.11
3.2	0.06	0.01	0.02–0.09	0.05	0.01	0.02–0.09
4.8	0.04	0.01	0.01–0.05	0.04	0.004	0.01–0.07

[1] Seven traps operated in Acadia Parish and 11 in Jefferson Davis Parish.

Table 2. Summary of average number of mosquitoes caught per trap per night and frequency of catch in 2 parishes in southwestern Louisiana during 1984. Total number of trap nights was 363 and 530 for Acadia and Jefferson Davis parishes, respectively. (The order of species within this and subsequent tables reflects the frequency of occurrence in collections in Acadia Parish.)

	Acadia			Jefferson Davis		
Species	Freq.	Mean	SE	Freq.	Mean	SE
Ps. columbiae	0.96	1,331	473	0.93	794	207
Cx. sal./errat.	0.80	411	145	0.77	201	45
An. crucians	0.68	416	168	0.70	353	81
An. quadrimaculatus	0.52	167	47	0.30	150	25
Ur. sapphirina	0.11	137	46	0.02	30	14
Cq. perturbans	0.09	14	4	0.12	21	5
Ps. ciliata	0.07	6	4	0.05	4	2
Ae. vexans	0.04	48	19	0.03	15	6
Cs. inornata	0.03	6	2	0.00	1	0.5
Ae. sollicitans	0.01	32	17	0.01	38	16
Parish mean		279			200	

Table 3. Regression coefficients for the model annual average catch in New Jersey light traps on the independent variables of cattle abundance per hectare within annuli of increasing radii (km) from the trap locations. Data collected during 1984 in Acadia Parish, LA.

		Model coefficients				
Species	Intercept	0.8	1.6	3.2	4.8	R^2
			Acadia Parish			
Ps. columbiae	312.3	4,240.1	—	—	—	0.97
An. crucians	114.1	1,255.7	—	—	—	0.68
An. quadrimaculatus	79.7	363.7	—	—	—	0.74
			Jefferson Davis Parish			
Ps. columbiae	—	—	—	—	—	—
Cx. salinarius/erraticus	140.1	437.8	—	—	—	0.47
An. crucians	250.8	675.5	—	—	—	0.41
An. quadrimaculatus	263.9	278.0	−568.0	4,683.0	−8,827.8	0.94

The analysis for Jefferson Davis Parish (Table 3) indicates that mosquito abatement efforts (as examined by inclusion of the number of times adulticidal sprays were conducted within a 4.8-km radius of each trap) were not significantly correlated with the captures for any species. Although such control actions are conducted when large captures occur, they also occur because of landing rate counts the morning before the trap is operated, resulting in the trap being sprayed during its operation. Other traps near large urban human populations tend to be sprayed more frequently when mosquitoes are fewer, than are other traps not located in sensitive areas. Therefore, abatement actions can severely affect trap captures without necessarily being correlated to the observed capture rates. Not unexpectedly in Jefferson Davis Parish, then, predictions of mosquito captures based on knowing host densities are less precise (5 of the 10 species had significant regressions, average $R^2 = 68\%$) than the results for Acadia Parish. We include the data from Jefferson Davis Parish to illustrate one possible reason why the important relationship of cattle to the overall seasonal populations has not been evident from past studies conducted only in areas where control actions exist.

Another possible explanation exists for the differences in correlation between the 2 areas. The unknown distribution of cattle within similar annuli could have varied both spatially and temporally during the season, permitting correlations to exist for *Ps. columbiae* in one parish but not the other.

With regard to the 2 anophelines, the significant relationships remained; however, in both cases increases in host abundance were not associated with increases in captures as large as those predicted for Acadia Parish (compare coefficients for cattle density at the 0.8-km radius). This observation agrees with the hypothesis that increased cattle densities result in increased numbers of mosquitoes and hence control activities in the vicinities of light traps. The regression for *Cx. salinarius* and *Cx. erraticus* was significant. In contrast to Acadia Parish, trap captures are attributable to differences in host density in 7 of the 10 species listed in Table 2.

Our study suggests that mosquito abatement strategists should place more emphasis on the importance of this significant relationship between mosquitoes and their primary hosts. Seen as attractors, cattle can serve to concentrate mosquitoes and make them available for suppression measures. Alternatively, manipulation of host distribution may serve to significantly influence mosquito population densities. In conclusion, host abundance and distribution play a more determinant role in mosquito population dynamics than is commonly perceived. Utilization of this concept for host management stratagems for riceland mosquito control should be productive.

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