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MOSQUITO SPECIES INHABITING RICEFIELDS IN FIVE RICE GROWING REGIONS OF ARKANSAS

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ABSTRACT. Mosquito larvae of 5 species were identified in 5 riceland regions of Arkansas. *Psorophora columbiae, Anopheles quadrimaculatus* and *Culex erraticus* were the 3 most commonly found and were present in all regions sampled. *Aedes vexans* was present only in the E region. *Uranotaenia sapphirina* was found in 3 regions. No significant difference in species occurrence was found among areas. Only one significant correlation of a mosquito species with changes in environmental factors was found: *An. quadrimaculatus* with water depth fluctuation.

Ricefield habitats provide breeding sites for the dark ricefield mosquito, *Psorophora columbiae* (Dyar and Knab), the malaria mosquito, *Anopheles quadrimaculatus* (Say), and several other species. Arkansas is one of the leading rice producing states in the US with ca. 6,000,000 ha in rice production. Most of these rice growing regions are in the eastern half of the state, although some acreage exists in central Arkansas counties bordering the Arkansas river, and some acreage is found in the southwestern counties.

Mosquitoes inhabiting ricefields have been identified as pests of cattle, causing weight gain reduction (Steelman et al. 1972, 1973, 1976, 1977). *Psorophora columbiae* has been shown capable of transmitting Venezuelan equine encephalitis (VEE) and cattle anaplasmosis (Sudia et al. 1971). In addition *Ps. columbiae* have a population peak from mid-June to mid-July (Coombes et al. 1977) which can be an extreme nuisance to farmers and residents near ricefields in Arkansas. *Anopheles quadrimaculatus* could pose a serious health threat if malaria were ever reintroduced in the area.

Studies of larval mosquito distribution

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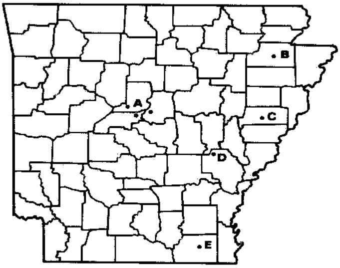
have lagged behind species distribution studies for adults. Chambers et al. (1979) provided a concise background of studies for larvae in Louisiana, Texas and California. Other major rice producing states in the U.S. have also conducted larval distribution surveys (Olson 1980, personal communication). No extensive geographic larval sampling has been carried out in Arkansas, however. The aim of this study was to include samples from all the major rice growing regions in Arkansas, showing distribution and abundance of species common to the ricefield agroecosystem. Regional similarities and differences are described and correlations of mosquito numbers with environmental parameters shown.

Differences of species occurrence in ricefields and records of species from past studies are noted. Past studies in Arkansas seldom contained relative abundances but usually comprised species lists. Adult and larval studies by Whitehead (1952) indicated that a high proportion of ricefield mosquitoes in E Arkansas were *Ps. columbiae* and *Ps. discolor* (Coquillett). Schwardt (1939) noted 89% *Ps. columbiae* and 10% *An. quadrimaculatus* in light trap survey of adults in the area of Camp Robinson, in the Central Valley of Arkansas, finding *Aedes vexans* (Meigen) and *Culex* spp. to be the most numerous, followed by *Ps. columbiae* and *An. quadrimaculatus*. Horsfall (1937) reports on 29 mosquito species found in various habitats in SE Arkansas, but does not include any numbers or percentages. Problem mosquitoes in rice culture areas are listed as *Psorophora* species and *Culex* species.

MATERIALS AND METHODS

Five Arkansas rice growing regions reflecting different geographic areas, soil types, and irrigation sources were chosen as sample locations (Fig. 1). The first region, E Arkansas, the Grand Prairie, is the largest rice producing area, and has provided most of the data on larval mosquito distribution in Arkansas (Davey et al. 1978). The soil type is Eastern Arkansas Prairie, and rice is typically rotated with soybean: 1 year rice, 2 years soybean. Irrigation is usually by ground water wells. The second region, SE Arkansas, is in the Mississippi delta in Loessial Plains soils. Rice is rotated with soybean, but there are also areas of cotton. Irrigation is by ground water wells. Just north of the E region is the third region called Crowley's Ridge, also in Loessial Plains soils. Soybean is the other major crop here and irrigation is usually by ground water wells. Farther north in the vicinity of Jonesboro, rice is grown in Loessial Plains and Loessial Hills soils. Both of these areas rotate rice with soybean, and again some cotton is grown. Irrigation is again by ground water wells or reservoir. The fifth region is in central Arkansas bordering the Arkansas river. These ricefields are in Arkansas Valley soils and are scattered in river bottoms adjacent to the Arkansas river and its tributaries. Most are relatively new fields, and rotation is with soybean. Other crops here are rare, and irrigation is often by pumped river water.



LEGEND

A Central Arkansas Valley, Conway, Faulkner, Perry Co.
B NE Loessial Plains, Jonesboro, Craighead Co.
C Crowley's Ridge Loessial Plains, St. Francis Co.
D E Arkansas, Grand Prairie, Arkansas Co.
E SE Loessial Plains, Ashley Co.

Fig. 1. Rice growing areas of Arkansas sampled for mosquitoes in 1980.

Two ricefields in each of the first 3 (E, SE, and Crowley's ridge) regions were sampled weekly. In the other 2 regions 7 and 6 ricefields respectively were sampled each week. A weekly sample consisted of 3 random sites per field, each site yielding a sample from the ditch and adjacent pan sections. Each ditch and pan sample consisted of 10 aquatic sweep net samples combined, plus 10 mosquito dipper samples combined. For aquatic sweep net samples, a 30.5 cm/side D-frame net was used, and 1 m/sweep was covered in each of the 10 sweeps. Each 10 m sweep sampled 405 liters of water. Dipper samples consisted of 10 dips and sampled 4.2 liters of water. Thus each field yielded 12 samples per week, each of which consisted of 10 actual sweeps or 10 dips from pan or ditch from each site. The dipper and sweep net samples were combined in the analysis by calculating number of larvae/dipper from the volume of water sampled.

Sampling continued for 7 to 10 weeks, with weeks of dry field conditions excluded. Throughout the summer season of 1980, 84 to 120 samples were taken from each field and each geographic region was sampled 168 to 840 times. In each area, water depth, air and water temperature, plant height and plant density were measured. In Jonesboro and in the Arkansas Valley area, pH and conductivity were also recorded. Analysis of variance was performed on numbers of 3 species from each of the 5 regions. The 3 species included were *Ps. columbiae, An. quadrimaculatus* and *Cx. erraticus* (Dyar and Knab).

RESULTS

Larvae of 5 mosquito species were identified in Arkansas ricefields. *Ps. columbiae, An. quadrimaculatus* and *Cx. erraticus* were found in all sampled regions. *Aedes vexans* was collected only in the E region, *Uranotaenia sapphirina* (Osten Sacken) was found in the E. Crowley's Ridge and Arkansas Valley regions.

Numbers of mosquito larvae per date varied considerably, and overall numbers/sample were low. Because of this, numbers reported for each area/date were pooled from all fields and all samples. Figure 2 is an illustration of total numbers collected per date per area. Peaks for each mosquito species vary among areas, but in general late June and July are periods of greatest abundance for all species. *Culex erraticus* numbers increase later in the season; however, this is not an especially pestiferous mosquito to humans. In addition, at the time *Cx. erraticus* populations are increasing, rice is nearing maturity and fields are soon drained for harvest.

As shown in Fig. 2, *Ps. columbiae* constituted the most serious problem in the SE. Three population peaks occurred, 1 in late June, and 2 in July. Occasionally fields were drained but reflooding began immediately, and before the next sample date the fields were flooded. Peaks of *Ps. columbiae* followed the reflooding of a dry field fairly consistently. Populations of *An. quadrimaculatus* were higher in June and July. Small *Cx. erraticus* peaks were seen in June, July and August. In the E area, in Stuttgart, *An. quadrimaculatus* was more prevalent than the other species. There were small *Ps. columbiae* peaks in late June, late July and again in August. In the Crowley's ridge area a large *An. quadrimaculatus* peak occurred in late July, followed by a large *Ps. columbiae* peak in July. Only a few *Cx. erraticus* were collected in the NE part of the state. There were lower total numbers of mosquitoes collected in the NE than in the E and SE areas. In the NE there was a peak of *Ps. columbiae* in early July and low numbers of *An. quadrimaculatus* throughout the summer.

In the Central area there were more *Cx. erraticus* collected than the other species with a peak in July. There were small peaks of *Ps. columbiae* in late June and early July as in other areas, and smaller peaks of *An. quadrimaculatus* in June and July.

Because of the wide variation in species densities through time, no statistical differences among total numbers of each species or between species numbers/dip/area could be detected. There was no consistent pattern of time variability common among species within a region or among regions. Rather, species abundances probably depend on local rather than regional conditions, and on differences in species life histories. Only vastly greater numbers of samples might detect differences considering the high variability.

Densities of *Ps. columbiae* did not show

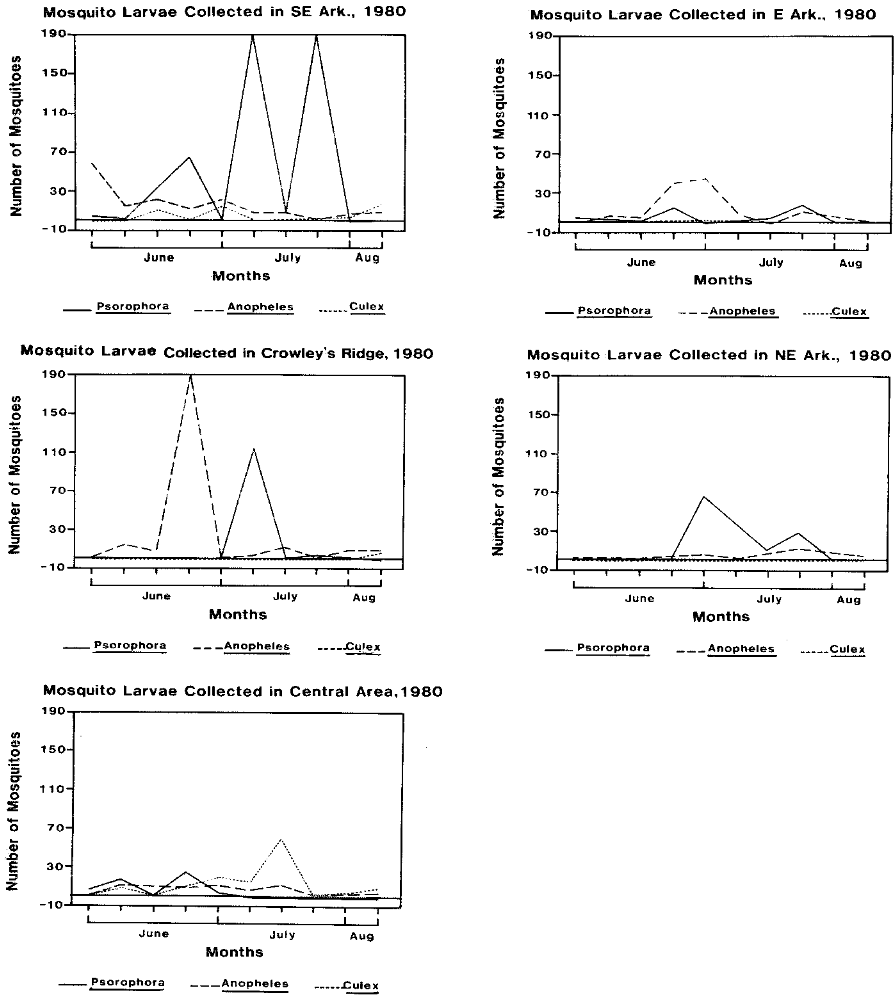


Fig. 2. Total numbers of mosquitoes collected in 5 areas of Arkansas.

significant correlations with any environmental parameters in any area. Numbers of *An. quadrimaculatus* showed a significant positive correlation ($r = 0.52$) with water depth change in the SE and E areas. Levels in the ditch and pan were averaged for the 3 replicate site samples and the average change in level from one week to the next used in the analysis. Since there was almost no measurable rainfall throughout the summer, rainfall did not affect water depth and was not measured. *An. quadrimaculatus* occurrence was also correlated with adult density in the Central Area. *Culex erraticus* occurrence was not found to be related to any biological or physical parameters, possibly due to the small numbers collected.

When multiple regression analyses were performed, very little of the variance could be accounted for by any combination of physical and biological parameters that were measured. The highest amount of variation accounted for by these parameters was in the SE and E areas, where 35% was accounted for by using all variables.

DISCUSSION

Because of the great variability in distribution of mosquitoes in ricefields, no significant differences were found among areas of the field in any of the 3 common species identified. Populations of ricefield mosquitoes in California have also been found to have a very complex distribution, and to change in distribution from early to later instars (Schaefer 1980, personal communication). As many as 100 samples/date/field were used in the California analysis compared to 12 in this analysis. According to reports of residents in various areas, the southeastern part of the state had by far the most serious *Ps. columbiae* adult problem. The northeastern area had mainly *Ps. columbiae* in ricefields, but light trap surveys in Jonesboro have shown high numbers of adults of all the species included in this study (Olson 1980, personal communication).

No other concurrent adult light trap surveys have been reported, but past surveys of adults in these areas show some interesting comparisons. No reports have been found of identified mosquito species collected in the NE rice section of Arkansas, but a central Arkansas valley study done at Camp Robinson (Carpenter 1941), (east of most of the present rice-growing area), found *Culex* spp. to be one of the most numerous groups collected, corresponding suprisingly to the predominance of *Cx. erraticus* in the ricefield samples. In the eastern and southeastern parts of the state, *Ps. columbiae* and *An. quadrimaculatus* have predominated in past surveys. In our collections in E Arkansas a trend toward more *An. quadrimaculatus* larvae than *Ps. columbiae* in ricefields can be seen. The same is not true of SE Arkansas, however.

The correlation of *An. quadrimaculatus* with water depth change may possibly have been due to the preference of this species for permanent water. *Anopheles quadrimaculatus* were present in highest numbers during the middle part of the season when water depth changes were high, due to continuous evaporation and flooding. Since *Ps. columbiae* oviposit on damp soil, their numbers were not correlated with average water depth change because peaks or variation in numbers did not occur every time water depth varied, but only when the water depth variation was due to dryness followed by flooding.

CONCLUSION

Essentially 3 species of mosquito larvae inhabit ricefields in 5 major rice-growing regions of Arkansas. Total numbers differ considerably, and peaks of each species vary, but extreme variability in samples prevents any significant differences from showing in numbers of larvae/dip/sample among areas. In order to further delineate the problem, more intense sampling must be carried out to determine larval distribution in ricefields.

Numbers of *An. quadrimaculatus* in some areas were related to water depth change. Since *An. quadrimaculatus* is a permanent water species, it peaked when fields were being flooded continually. This continuous evaporation and flooding caused the amount of change in water depth to be high, though fields were never totally dry. *Psorophora columbiae* attained peak levels in 3 areas followed reflooding of drought-dried fields fairly consistently.

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