A BLOOD HOST STUDY OF RICELAND MOSQUITOES IN ARKANSAS COUNTY, ARKANSAS

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ABSTRACT. Blooded mosquitoes were captured in 2 areas of Arkansas County, Arkansas. One area was primarily concerned with rice and soybean production. Livestock were extremely rare here. The other area was slightly upland and contained scattered herds of cattle and large wooded areas as well as rice and soybean fields. In the upland area cattle, horses and rabbits, in order of importance, were the most important identified hosts of *Psorophora columbiae* and *Anopheles quadrimaculatus*. Cattle, rabbits and birds were major hosts of *Culex erraticus* in this area. In the rice-producing area, horses and rabbits were the most important identified host of *An. quadrimaculatus*. Very few engorged individuals of *Ps. columbiae* and *Cx. erraticus* were collected. In comparison to the upland area, very few blooded mosquitoes were captured in the rice producing region.

INTRODUCTION

Arkansas County is located in the central part of eastern Arkansas. Mosquitoes in the county are produced in large acreages of rice fields and from low, wooded areas subject to flooding by streams and rivers. Primary pest species are *Psorophora columbiae* (Dyar and Knab) and *Anopheles quadrimaculatus* (Say). Mosquitoes in Arkansas County must be considered a serious threat to the health of man and animals as well as an extreme nuisance.

Whitehead (1952) conducted a blood-host study in Arkansas County in which blooded mosquitoes were captured with light traps from a farmyard and were tested using the precipitin method. This study indicated that cattle, horses, pigs, humans and birds in descending order of importance provided the main blood sources for *Ps. columbiae* and *Ps. discolor* (Coquillett), but results were obviously biased toward animals in the farmyard. Results of studies from neighboring states by King and Bull (1923) and Schaefer and Steelman (1969) in Louisiana and Kuntz[1] in Texas indicated that cattle and horses were the main hosts of *Ps. columbiae* and *An. quadrimaculatus*.

Agriculture in Arkansas County has changed since Whitehead's study. Rice and soybean acreages are much more extensive and livestock are of minimal importance except in border areas of the county where scattered cattle herds and other livestock occur. In light of these changes this study was conducted to determine the major hosts of mosquitoes in areas where cattle are rare (rice production dominates) and where scattered herds of cattle are present.

METHODS AND MATERIALS

The first area chosen was in the north-central part of the county (Almyra area). Most of this area was planted in rice or soybeans. Domestic animals apparent in this area were dogs, horses and cats. No cattle were present. A community of approximately 220 people adjoined the area.

The second area was located near the northeast border of the county (Casscoe area). This area was chosen because it represented the interface between pastures and cultivated fields and forest. Domestic animals apparent in this area were cattle, horses, dogs, cats, chickens, pigs, goats and ducks. Two communities of approximately 100 people each were located within this area.

[1] K. J. Kuntz, Unpublished Ph.D. Thesis, Texas A&M University, College Station, TX.

Blooded mosquitoes were collected using a truck trap, resting stations, backpack aspirators, and from barns by hand-held aspirators. The truck trap was built according to the specifications of Steelman et al. (1968). The resting stations were constructed as outlined by Edman et al. (1968).

After collection mosquitoes were sorted according to sex, species and blooded status on a chill table. Whole blooded mosquitoes were placed in gelatin capsules, 5/capsule, and stored in a freezer at −24°C. Mosquitoes were tested following capillary precipitin procedures outlined by Tempelis and Lofy (1963). Antisera were obtained primarily from the National Institutes of Health Research Resources Branch, Bethesda, MD. Some antisera were purchased from Grand Island Biological Company, Grand Island, NY and Cappel Laboratories, Incorporated, Cochranville, PA. Four screening sera were used. These were mammalian, avian, reptilian, and amphibian antisera. More specific antisera used were cow, horse, dog, cat, pig, deer, human, beaver, raccoon, rabbit, Norway rat, white-footed mouse and chicken. All antisera had a minimum titer by capillary tube test of 1:10,000 based on the dilution of whole serum. Blood meals which tested positive to one of the screening antisera but not to any of the specific antisera were classified as "unknown" in the respective category. Those which did not react to any of the antisera were listed as "unidentified."

RESULTS

Blood meal identifications of *An. quadrimaculatus* from the Almyra area (Table 1) revealed that unknown mammalian sources provided almost 20% of the blood meals. Horses were the next most numerous source composing 16.9% of the blooded *An. quadrimaculatus*. Rabbits were the second most important recognized source. The total percentage of blooded *An. quadrimaculatus* having fed on mammals was 52.1%. Only 8 blooded *Ps. columbiae* were captured in the area. Iden-

Table 1. Blood meal identification from 3 mosquito species collected in the rice producing area of Arkansas County, Arkansas.

	An. quadrimaculatus		*Ps. columbiae*		*Cx. erraticus*	
Host	No.	%	No.	%	No.	%
Mammalian						
bovine	—	—	2	25.0	—	—
deer	—	—	—	—	—	—
horse	57	16.9	—	—	—	—
dog	—	—	—	—	—	—
cat	3	0.9	—	—	—	—
rabbit	29	8.6	—	—	3	6.6
human	1	0.3	—	—	—	—
pig	10	3.0	—	—	—	—
raccoon	9	2.6	1	12.5	—	—
beaver	1	0.3	—	—	—	—
unknown	66	19.5	—	—	—	—
Subtotal	176	52.1	3	37.5	3	6.6
Avian						
chicken	—	—	—	—	—	—
unknown	1	0.3	—	—	9	20.0
Subtotal	1	0.3	—	—	9	20.0
Amphibian	—	—	—	—	—	—
Reptilian	—	—	—	—	1	2.2
Unidentified	161	47.6	5	62.5	32	71.2
Total	338	100.0	8	100.0	45	100.0

tified blood sources were cattle and raccoon. *Culex erraticus* (Dyar and Knab) from this area had fed mostly on avian sources. The percentage of unidentified hosts was high for all 3 species. Forty-seven percent of blooded *An. quadrimaculatus* were not identified, and 62% and 68% of *Ps. columbiae,* and *Cx. erraticus* respectively were unidentified. This may have been due to testing mosquitoes whose abdomens were distended by material other than blood and mosquitoes with insufficient blood.

In the Casscoe area mammals, generally, and cattle, specifically, provided most blood meals for all 3 species (Table 2). Seventy-five percent of blooded *An. quadrimaculatus* had fed on bovine sources. Cattle were only slightly less important as hosts of *Ps. columbiae* with 63% having fed on cattle and 10% on horses. Four percent of the *Ps. columbiae* feedings were from rabbits. Cattle, rabbits, and birds provided most of the identified blood meals from *Cx. erraticus*. The percentage of blooded mosquitoes whose hosts were unidentified was lower in the Casscoe area with 12.3%, 13.3%, and 44.5% of *An. quadrimaculatus, Ps. columbiae,* and *Cx. erraticus* respectively remaining unidentified as to blood source.

Cattle were the most important blood source for barn-collected *An. quadrimaculatus* and *Ps. columbiae* as expected (Table 3). Horses were second in importance for both species. Only about 7% of blooded mosquitoes of both barn-collected species were unidentified as to blood source.

Multiple feedings were recorded in the Casscoe area for *Ps. columbiae* for barn-collected *An. quadrimaculatus*. It is not difficult to see how multiple feedings may have occurred in barns containing several species of animals in close proximity, as was the case. Multiple feedings are not as easily explained in field-collected *Ps. columbiae*.

Overall the greatest difference between the rice growing region and the areas

Table 2. Blood meal identification from 3 mosquito species collected in the upland-cattle area of Arkansas County, Arkansas.

	An. quadrimaculatus		*Ps. columbiae**		*Cx. erraticus*	
Host	No.	%	No.	%	No.	%
Mammalian						
bovine	55	75.3	319	63.9	5	18.5
deer	—	—	2	0.4	—	—
horse	1	1.4	51	10.2	—	—
dog	—	—	4	0.8	—	—
cat	—	—	1	0.2	—	—
rabbit	—	—	22	4.4	4	14.8
human	—	—	—	—	—	—
pig	—	—	1	0.2	—	—
raccoon	—	—	1	0.2	—	—
beaver	—	—	—	—	—	—
unknown	5	6.9	30	6.0	1	3.7
Subtotal	61	83.6	431	86.4	10	37.0
Avian						
chicken	—	—	1	0.2	3	11.1
unknown	3	4.1	1	0.2	1	3.7
Subtotal	3	4.1	2	0.4	4	14.8
Amphibian	—	—	—	—	—	—
Reptilian	—	—	—	—	1	3.7
Unidentified	9	12.3	66	13.2	12	44.5
Total	73	100.0	499	100.0	27	100.0

*Includes 31 double and 1 triple feeding.

Table 3. Blood meal identification from 2 mosquito species collected in barns in Arkansas County, Arkansas.

Host	*An. quadrimaculatus**		*Ps. columbiae*	
	No.	%	No.	%
Mammalian				
bovine	166	58.4	65	81.2
horse	52	18.3	6	7.5
dog	15	5.3	2	2.5
cat	13	4.6	1	1.3
rabbit	10	3.5	—	—
human	3	1.1	—	—
pig	3	1.1	—	—
unknown	—	—	—	—
Subtotal	262	92.3	74	92.5
Avian				
chicken	2	0.7	—	—
unknown	—	—	—	—
Subtotal	2	0.7	—	—
unidentified	20	7.0	6	7.5
Total	284	100.0	80	100.0

* Includes 22 double and 1 triple feeding.

with more livestock is not in the bloodhosts recorded or the seasonal trends, but in percentages of blooded mosquitoes found in each region. Collection methods consistently yielded a greater percentage of blooded mosquitoes in the Casscoe than in the Almyra area. The most striking example of this is that only 8 blooded *Ps. columbiae* were collected in the Almyra area, but 499 blooded *Ps. columbiae* were collected in the Casscoe area. Similarly 4,184 blooded *An. quadrimaculatus* were collected in the Casscoe area and 338 were collected in the Almyra area. This disparity is easily explained by the scarcity of cattle and horses in the Almyra area.

Where cattle were present, they were the main riceland mosquito hosts. Cattle provided about 75% of the bloodmeals for *An. quadrimaculatus* and almost 64% for *Ps. columbiae*. Some mosquitoes that tested positive for bovine blood may have fed on deer, goats or sheep since ruminant bloods often cross-react. In the rice-growing area where there are few livestock, the few horses kept for pleasure riding provided almost 17% of the bloodmeals for *An. quadrimaculatus*. Wild hosts were also important in this area. Rabbits provided almost 9% of the blood meals for *An. quadrimaculatus*. The results of the precipitin tests agree well with the study conducted by Whitehead (1952) in this area. He found that 68.7% of the tested *Ps. columbiae* had fed on bovines and 16.4% and 13.5% had fed on swine and equine hosts respectively. The differences in these 2 studies probably reflect changes in the abundance of certain kinds of livestock rather than changes in *Ps. columbiae* host preference. The data agree well with the results obtained by Schaefer and Steelman (1969) and Kuntz (1977, personal communication) in Louisiana and Texas riceland areas respectively. It is interesting to note that human feedings were only recorded for *An. quadrimaculatus*, an important potential vector of malaria.

This study did reveal the main mosquito species in the area, their primary blood hosts, and a relationship between livestock density and engorged mosquito density. It also provided information regarding trapping methods for collecting engorged mosquitoes. The data reported here are not sufficient to justify detailed conclusions regarding all mosquito species in this area. A more definitive study would include more intensive trapping, species and abundance surveys of wild and domestic animals, and blood meal tests against a greater array of antisera.

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INHERITANCE OF *BALD PALPI* AND *BALD ANTENNA* IN *ANOPHELES ALBIMANUS*[1]

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ABSTRACT. *Bald palpi (bp)* and *bald antenna (ba)* are fully penetrant, recessive, autosomal mutants of *Anopheles albimanus*. These new mutants are visible only in the adult stage, and the expression of *bald antenna* is limited to males. Genetic crosses were used to assign *bald palpi* to the right arm of chromosome 2. *Bald antenna* is loosely linked to *nonstripe (st)* on chromosome 3.

The inheritance and linkage groups for several mutants and enzymes were noted in a recent report by Narang et al. (1981) on *Anopheles albimanus* Wiedemann, the most important vector of human malaria in Central America. We are involved in conducting genetic and cytogenetic studies of *An. albimanus* with the intention of using this information in devising better strategies for the control of this species.

In this present paper, we describe the mode of inheritance of *bald palpi (bp)* and *bald antenna (ba)*, both of which are recessive, autosomal traits expressed only during the adult stage. The expression of *bald antenna* is limited to the male sex.

METHODS AND MATERIALS

Established procedures were employed for rearing and maintenance of the mosquitoes (Rabbani and Seawright 1976, Seawright et al. 1979). An inbreeding scheme was used to obtain the mutants.

Appropriate crosses (Tables 1–6) were used to determine the mode of inheritance and the linkage group for the 2 mutants. Other mutants and stocks used in the linkage study included: *red eye (re)* on 2R (unpublished), *propoxur resistance* (pr^r) on 2R (Kaiser et al. 1979), *T(Y;2R)1*—a male linked translocation (Rabbani and Kitzmiller 1972), and *nonstripe (st)* on 3R (Rabbani and Seawright 1976). Crossing over occurs on the 2 autosomes of both sexes of *An. albimanus* (Kaiser et al. 1979). Sex determination is an XY system in this species, and the male is the heteromorphic sex (Keppler et al. 1973).

RESULTS

Bald palpi (bp) is expressed in both sexes in the adult stage as a lack of scales over the distal half of the maxillary palpi. The proboscis and the palpi of both sexes curve slightly downward, and in cases of

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