MOSQUITO DENSITIES AT HEIGHTS OF FIVE AND TWENTY-FIVE FEET IN SOUTHEASTERN MASSACHUSETTS[1]

A. J. MAIN, R. J. TONN, E. J. RANDALL AND K. S. ANDERSON[2]

INTRODUCTION. During 1963 a study on the vertical distribution of mosquitoes was begun by the Encephalitis Field Station. This is one of a series of studies conducted in southeastern Massachusetts on the ecology of possible vectors of eastern (EE) and western (WE) encephalitis (Hayes, 1958; Hayes & Doane, 1958; Hayes, 1961; Hayes, 1962). This paper is a preliminary report of the results of this study over the past three years.

PROCEDURE. During 1963 an area was selected for this study in Pine Swamp, a 658-acre, white cedar-red maple swamp in Raynham, Massachusetts. This swamp is one of the established study sites of the Encephalitis Field Station and the species and populations of mosquitoes in the vicinity are known.

New Jersey light traps with 25-watt white frosted bulbs were set at heights of 5 and 25 feet above the ground. These traps were run simultaneously one night a week, from mid-June through mid-October in 1963.

In 1964, lard-can bait traps (Bellamy and Reeves, 1952) with chicks as bait were substituted for the light traps. These traps were run simultaneously several nights each week from mid-July through mid-September.

In June 1965 the study was continued with other baits used in addition to chicks. These included chipmunks (*Tamias striatus*), white-footed mice (*Peromyscus leucopus*), guinea pigs (*Cavia porcellus*), white rats (*Rattus norvegicus*), painted turtles (*Chrysemys picta*), and bull frogs (*Rana catesbeiana*). If possible, specimens were selected by their similarity in age, size, and sex. The traps were usually set out at about 4 p.m. and picked up at about 9 a.m. the next morning.

In July 1965, a second site was selected to supplement the findings in Pine Swamp. This area, also a study site of the Field Station, is a woodland plot where the cover is a mixture of red oak, black oak, red maple, and hickory. A brook in the plot seasonally overflows forming swampy areas along the banks. At this site wooden box type bait traps with chicks as bait were used. The traps from both sites were run almost daily through the end of September.

RESULTS. The seventeen species of mosquitoes collected during this study are listed in Table 1. Only the first six of the species listed were collected in sufficient quantity to enable a comparison of specimens collected at 5 feet to the number taken at 25 feet. Ratios given in this discussion will be in this form. The figures in Tables 2 through 6 are numbers and percentages of mosquitoes collected.

Culex pipiens were taken in approximately equal numbers in the low and high light traps. This ratio was approximately 1 to 1 for both sexes. Only females are collected in the bait traps. However, far more specimens were taken in the higher trap—1:6.3. Variation in ratios was slight for warm-blooded baits—1:6.3 for bird-baited traps and 1:6.2 for mammal-baited traps. Ten *C. pipiens* (all taken at 25 feet) were identified from traps baited with cold-blooded animals. Ratios also were similar for the two areas sampled—1:6.3 in the swamp and 1:8.0 in the wooded area. Monthly ratios varied somewhat from

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[2] Encephalitis Field Station, Department of Public Health, Lakeville Hospital, Middleboro, Massachusetts.

TABLE 1.—Species and numbers of mosquitoes collected by light traps (1963) and bait traps (1964 and 1965) at heights of 5 and 25 feet in Pine Swamp, Raynham, Massachusetts.

	Light traps		Bait traps	
	5′	25′	5′	25′
Culex pipiens	109	116	484	3042
Culex restuans	4	8	23	234
Culiseta melanura	1370	438	41	88
Culiseta morsitans	431	623	49	952
Aedes canadensis	962	595	21	3
Mansonia perturbans	62	90	62	25
Culex salinarius	3	4	2	2
Culex territans	20	8	0	0
Culiseta minnesotae	1	1	0	2
Aedes abserratus	29	27	0	2
Aedes aurifer	1	0	4	0
Aedes cantator	60	95	3	3
Aedes excrucians	1	5	2	3
Aedes cinereus	18	9	2	0
Aedes vexans	3	2	0	0
Aedes triseriatus	0	1	3	1
Uranotaenia sapphirina	10	5	0	0

1:4.0 in June to 1:7.3 in July. However, these variations cannot be regarded as significant.

Culex restuans were rare in the light traps, but they were commonly collected in the bait traps. As with *C. pipiens,* far more specimens were taken in the higher bait trap—1:10.2, although this ratio varied greatly by months: 1:6.3 in June, 1:20.7 in July, 1:4.0 in August, and 1:9.0 in September. Yearly variation was slightly greater in 1964—1:12.2—than in 1965—1:8.0. Baits made little difference in the ratio—1:10.0 for birds and 1:13.0 for mammals. None were taken in the traps baited with cold-blooded animals.

More than three times as many *Culiseta melanura* were collected in the lower light trap as in the higher one (3.1:1), while about half as many (1:2.1) were taken in the lower bait trap as in the higher one. There was little difference between the numbers of each sex collected in light traps at the 5 and 25 foot elevations—3.5:1 for females and 3.0:1 for males. Monthly collections varied greatly in the light traps—5/7 for June, 141/263 for July, 621/83 for August, and 505/84 in September. However, the monthly ratios were fairly constant in the bait traps. Yearly variation was also slight in the bait traps—1:2.0 in 1964 and 1:2.2 in 1965. No *C. melanura* were taken in traps baited with mammals or cold-blooded animals, or in the woodland area.

Culiseta morsitans were taken frequently in both the light traps (1:1.5) and the bait traps (1:19.4). In the light traps, males and females had about equal ratios, 1:1.6 and 1:1.2 respectively. Ratios varied with baits, 1:17.1 in bird-baited traps and 1:29.4 in mammal-baited traps. Seven specimens were taken from traps baited with cold-blooded animals, six of them at 25 feet. Monthly ratios varied only slightly: 1:19.0 in June to 1:27.0 in September. Only two specimens were taken in the woodland area, both in the higher trap.

Mansonia perturbans were taken in about equal numbers in the light traps (1:1.5) but in a different ratio in bait traps (2:4.1). Sex again made little difference in the light trap ratios, 1:1.6 for females and 1:1.2 for males. Ratios were about equal for mammal- and bird-baited traps, 2.6:1 and 2.5:1 respectively. Most of the specimens were taken in July.

Aedes canadensis frequently were taken in the light trap collections (1.6:1) but seldom in the bait traps (7.0:1). No valid conclusions could be drawn from the bait trap collections because of the insufficient numbers collected. In the light traps, sex made little difference in the ratios—1.8:1 for the females and 1.5:1 for the males.

DISCUSSION. Of the six species included in this study, three were taken in approximately equal numbers in the 5 and 25 foot light traps: 1:1.1 for *C. pipiens;* 1:2.0 for *C. restuans;* and 1:1.5 for *C. morsitans.* Each of these three species showed marked differences when collected at these two elevations in bait traps: 1:6.3 for *C. pipiens;* 1:10.4 for *C. restuans;* and 1:19.4 for *C. morsitans.*

A. canadensis were frequently collected in the light traps but seldom in the bait traps.

TABLE 2.—Numbers and percentages of mosquito es collected with different baits at two elevations in Pine Swamp, Raynham, Massac husetts during 1964 and 1965.

		Culex pipiens		*Culex restuans*		*Culiseta melanura*		*Culiseta morsitans*		*Mansonia perturbans*		*Aedes canadensis*	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Mammal	5′	30	14	1	7	0	X	10	3	8	73	2	X
	25′	188	86	13	93	0	X	294	97	3	27	0	X
Bird	5′	454	14	22	9	41	32	38	5	54	71	14	83
	25′	2844	86	221	91	88	68	651	95	22	29	2	17
Cold-blooded vertebrate	5′	0	X	0	X	0	X	2	X	0	X	5	87
	25′	10	X	0	X	0	X	6	X	0	X	1	13
All baits	5′	484	14	23	9	41	32	49	5	62	71	21	88
	25′	3042	86	234	91	88	68	952	95	25	29	3	12

X—Insufficient numbers.

TABLE 3.—Yearly percentages of mosquitoes collected during three years using light traps (1963) and bait traps (1964 and 1965) at two elevations.

		Culex pipiens		*Culex restuans*		*Culiseta melanura*		*Culiseta morsitans*		*Mansonia perturbans*		*Aedes canadensis*	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1963 (Light traps)	5′	109	48	4	33	1370	76	431	41	62	41	962	62
	25′	117	52	8	67	438	24	623	59	90	59	595	38
1964 (Bait traps)	5′	324	13	12	8	10	33	8	5	32	62	3	X
	25′	2219	87	146	92	20	67	147	95	20	38	1	X
1965 (Bait traps)	5′	160	16	11	11	31	31	41	5	30	86	18	90
	25′	823	84	88	89	68	69	805	95	5	14	2	10

X—Insufficient numbers.

TABLE 4.—Numbers and percentages of males and females collected at two elevations in light traps in Pine Swamp, Raynham, Massachusetts during 1963.

		Culex pipiens		*Culex restuans*		*Culiseta melanura*		*Culiseta morsitans*		*Mansonia perturbans*		*Aedes canadensis*	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Males	5′	58	44	1	X	896	75	352	39	15	46	692	61
	25′	73	56	0	X	303	25	540	61	18	54	447	39
Females	5′	51	54	3	27	474	78	79	49	47	39	270	65
	25′	43	46	8	73	135	22	83	51	72	61	148	35
Males and females	5′	109	48	4	33	1370	76	431	41	62	41	962	62
	25′	116	52	8	67	438	24	623	59	90	59	595	38

X—Insufficient numbers.

TABLE 5.— Number and percentages of mosquitoes collected in bait traps at two elevations in two areas in Raynham, Massachusetts.

	Swamp (1964 and 1965)				Woodland (1965)			
	5′		25′		5′		25′	
	# Col.	%	# Col.	%	# Col.	%	# Col.	%
Culex pipiens	484	14	3042	86	14	11	112	89
Culex restuans	23	9	234	91	1	X	1	X
Culiseta melanura	41	32	88	68	0	X	0	X
Culiseta morsitans	49	5	952	95	0	X	2	X
Mansonia perturbans	62	71	25	29	0	X	0	X
Aedes canadensis	21	88	3	12	0	X	0	X

X—Insufficient numbers.

TABLE 6.—Monthly numbers and percentages of mosquitoes collected at two elevations with bait traps (1964 and 1965) in Pine Swamp, Raynham, Massachusetts.

		June		July		August		September		Totals	
		5′	25′	5′	25′	5′	25′	5′	25′	5′	25′
C. pipiens	No.	32	128	272	1990	108	480	72	444	484	3042
	%	20	80	12	88	18	82	14	86	14	86
C. restuans	No.	3	19	7	145	9	36	4	36	23	234
	%	14	86	5	95	20	80	10	90	9	91
C. melanura	No.	30	60	10	17	1	2	0	9	41	88
	%	33	67	37	63	X	X	X	X	32	68
C. morsitans	No.	1	19	36	672	9	180	3	81	49	952
	%	5	95	5	95	5	95	4	96	5	95
M. perturbans	No.	6	0	53	23	3	2	0	0	62	25
	%	X	X	70	30	X	X	X	X	71	29
A. canadensis	No.	5	1	13	1	3	1	0	0	21	3
	%	83	17	93	7	X	X	X	X	87	13

X—Insufficient numbers.

C. melanura and *M. perturbans* both reversed population ratios with the two trapping methods. *C. melanura* were taken at a ratio of 3.1:1 in the light traps and 1:2.1 in the bait traps; *M. perturbans,* at the ratio of 1:1.5 in the light traps and 2.4:1 in the bait traps.

The reasons for these differences are not clear. Several possible explanations can be given.

1. Intrinsic differences in trapping methods. However, in an attempt to offset any host variation, baits were selected at random from animals as nearly equal in size, and age. Specimens of the same sex were used whenever possible. In addition, both bait traps and light traps were found to collect approximately equal numbers when operated simultaneously at 5 feet.

2. Only host-seeking females are attracted to the bait traps while both males and females are caught in the light traps. In all six species studied, however, ratios for males and females were found to be approximately equal as shown in Table 4. Hayes *et al.* (1958) found that light traps and bait traps with dry ice presented comparable population indices for *C. tarsalis.* This however, is not necessarily true for any other species.

3. Insufficient numbers collected. This might be true for *C. restuans* which were taken in low numbers in the light traps, and *A. canadensis* which were not common in the bait traps, but it seems highly unlikely for the remaining four species.

4. Yearly differences might present another possibility. The drought that the Northeast experienced during 1964 and 1965 affected the mosquito populations; whether the vertical distribution is different during a year of normal rainfall is not known. Bast *et al.* (1964) found reversals in the ratios of *Culex* spp. and *C. melanura* while using light traps at 5- and 25-foot elevations in New Jersey. They found *Culex* spp. (mainly *C. salinarius*) to be more frequent at 25 feet in 1961, but at 5 feet in 1962, and 1963; and *C. melanura* at 25 feet in 1961 and 1962, but at 5 feet in 1963.

5. Overlap in strata in the attraction of mosquitoes to the light trap, since the light can be seen at any height. Bast *et al.* (1963, 1964) used a collar to diffuse the light source above and below the trap, but its efficiency is not known.

It is interesting to note that three of the four species collected more frequently at the higher elevation are involved in the

avain transmission cycle of encephalitis. EE and WE have been isolated, in nature, from *C. melanura* and *C. restuans,* and WE from *C. pipiens,* (Chamberlain *et al.,* 1951; Hammon *et al.,* 1945; Hayes *et al.,* 1960; Hayes *et al.,* 1961; Norris, 1946). All four species are ornithophilic.

Of the two species collected more frequently in the lower bait traps, WE has been isolated from *A. canadensis* (Hayes *et al.,* 1961) and EE from *M. perturbans* (Howitt *et al.,* 1949). Both species are possible vectors associated with mammalian hosts.

SUMMARY. A comparison of mosquito densities at heights of 5 and 25 feet using light traps and bait traps was made. Of the six species studied the four ornithophilic species were more abundant at the higher elevation.

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