

MOSQUITO BITING ACTIVITY IN MICHIGAN STATE PARKS¹VAUGHN E. WAGNER² AND H. D. NEWSON³

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ABSTRACT. Mosquito biting activity was studied in the Michigan park system from 1971 to 1973. Results indicated that woodland *Aedes* mosquitoes were the problem species in the majority of state parks. Adult collections made at North Higgins Lake and Yankee Springs parks in 1972 and 1973 revealed that mosquitoes of the *A. communis-trichurus* and *A. stimulans-fitchii* species complexes were the major pests in these two parks. The former complex was a problem at

North Higgins Lake Park with highest biting activity occurring in late May and early June. The latter complex was a problem at Yankee Springs Park during most of the summer with biting activity extending until mid-August. Highest activity for the 2-year study occurred during June and July. The sampling trials at each park were conducted at 3 areas designated for public use and at peak biting levels recreational activities were cancelled by park personnel.

INTRODUCTION. Adult mosquito surveys were conducted in selected Michigan state parks during 1971-1973. The primary objectives were to determine the human-biting species present at public use areas and to study the duration and intensity of mosquito biting activity. The need for studies on species composition, relative abundance, and seasonal distribution was emphasized due to increased awareness of potential arthropod disease activity (Gorton et al. 1975) as well as widespread disruption of human recreational activities. Previous information on mosquito biting activity in Michigan parks was non-existent.

SURVEY METHODS. In 1971 eleven park areas (Fig. 1) in Michigan were chosen for mosquito surveys that included adult landing and biting collections. Park naturalists conducted the surveys in public use areas within each park. The collections were sent to the medical entomology laboratory at Michigan State University for identification. Based upon this survey North Higgins Lake and Yankee Springs, recreation areas located in north central and southern Michigan, respectively, were selected for further studies. Biting collections were continued at these 2 parks in

1972 and 1973. North Higgins Lake Park is located on the northern end of Higgins Lake in a hardwood and pine forested area and consists of 429 acres. The Yankee Springs recreational area is located on Gun Lake and comprises 4,972 acres in a maple and oak hardwood forest region. The biting count collections were standardized as follows:

1. Sampling trials were begun with emergence of *Aedes* snowpool mosquitoes and conducted every 7th day between 8:00 and 10:00 a.m.
2. Each sampling trial consisted of human-bait collections taken by 2 park personnel at each of 3 public use sites (nature trail, outdoor educational center, and overnight campground). Mosquitoes initiating biting activity during a 10-minute period were manually aspirated from the entire body of 1 of the collectors and retained for later identification.
3. Biting counts were discontinued when the mean number of mosquitoes collected during 1 sampling trial was < 10 for 2 consecutive weeks.

RESULTS. A total of 848 adult mosquitoes submitted from the 10 state park areas was identified (no adult specimens were submitted from North Higgins Lake) in 1971 to determine the species composition and frequency of occurrence throughout the park system. Table 1 lists the species of mosquitoes identified from landing and

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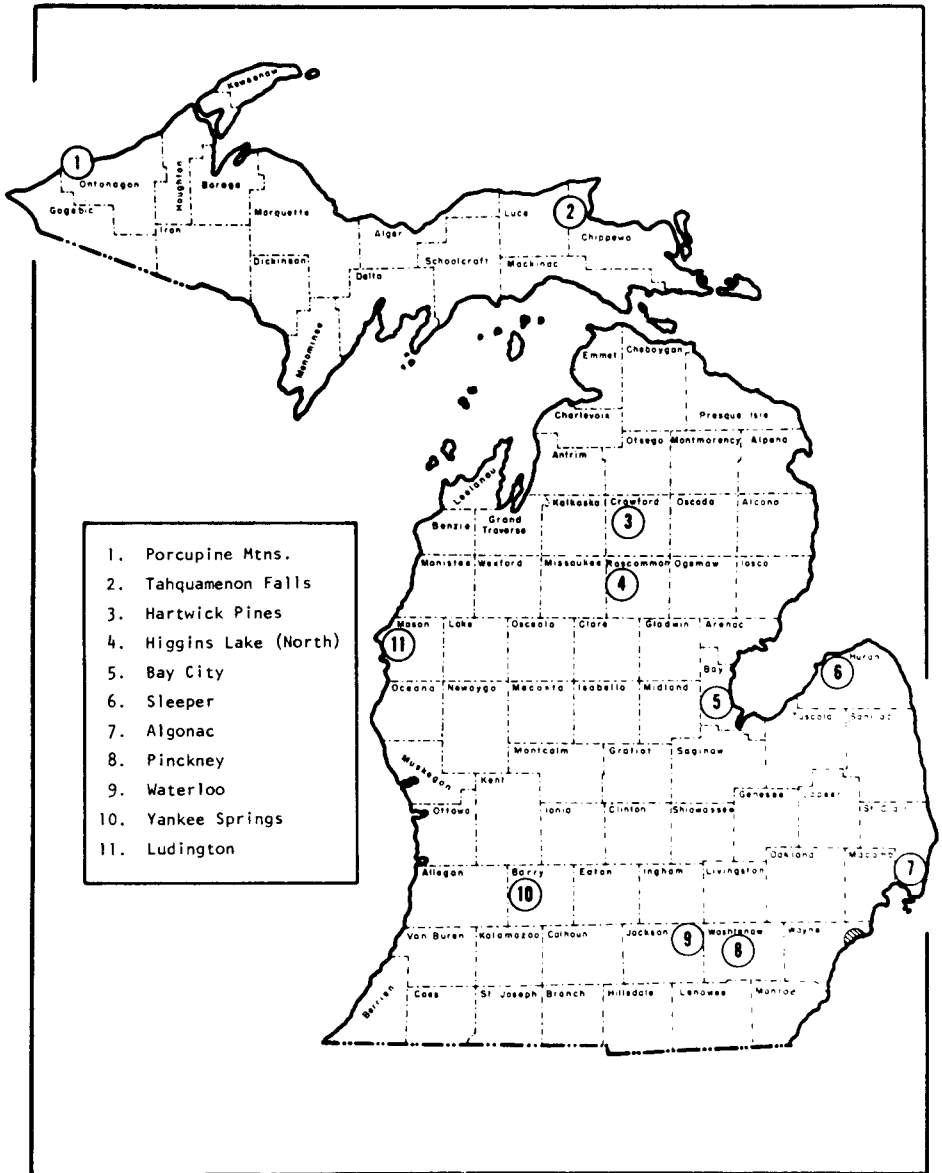


Fig. 1. Park and recreational areas in Michigan where mosquito surveys were conducted during 1971. Size in acres of each park is as follows: 1—58,327; 2—19,244; 3—9,138; 4—428; 5—106; 6—963; 7—981; 8—9,612; 9—17,053; 10—4,971; 11—4,156.

Table 1. Percent composition of the major mosquito species in landing/biting collections made in ten state parks, 1971.

Park	Total No.	<i>Aedes</i> snowpool group	<i>Coquillettidia perturbans</i>	<i>Aedes vexans</i>	<i>Anopheles quadrimaculatus</i>	<i>Aedes triseriatus</i>	<i>Culex pipiens</i>
1	70	50.0	32.9	1.4	...	7.1	7.1
2	367	90.2	1.1	7.4	...	1.3	...
3	28	88.0	12.0	...	...	...	...
4 ^a	..	...	...	...	...	...	...
5	112	30.4	<1.0	10.7	46.4	...	...
6	81	58.0	2.5	6.2	28.4	4.9	...
7	21	80.9	19.1	...	...	...	...
8	30	40.0	...	...	30.0	...	23.3
9	53	...	92.3	...	7.7	...	...
10	69	42.0	20.3	23.2	...	10.1	4.4
11	17	23.5	76.5	...	...	...	...

^a No adult samples submitted from North Higgins Lake

biting collections made in the 10 parks during 1971. The *Aedes* snowpool group was the most abundant species group collected in 7 parks (range 40.0% in park 8 to 90.2% in park 2) while *Coquillettidia perturbans* (Walker) constituted 76.5 and 92.3% in parks 9 and 11 and *Anopheles quadrimaculatus* Say comprised 46.4% of the sample from park 5. *Aedes vexans* (Meigen), *A. triseriatus* (Say) and *Culex pipiens* Linn. made up the remaining portion of the sample population. Frequency of occurrence and the percentage of the total number of collections in which a certain species or species group occurs is also shown in Table 1. The *Aedes* snowpool group and *C. perturbans* had the highest frequency of occurrence, being present in 90% of the park samples. During the same collection periods *A. vexans* was present in 50% of the samples while *A. quadrimaculatus* and *A. triseriatus* showed a frequency of occurrence of 40%. *C. pipiens* had the lowest frequency of occurrence of 30% in the park collections. The *Aedes* snowpool group was further determined to species or species complex for each park collection. The results are shown in Figure 2. The *A. stimulans* complex was most abundant in 7 parks, comprising 100% of the snowpool group in 4 park areas. The *A. communis* complex was present in samples submitted from 3 northern parks, being the most abundant in park 2 (73.15%). *A. cana-*

densis (Theobald) was the most abundant in park 3 where it comprised 68.2% of the sampled *Aedes* snowpool group. The least abundant of this group was *A. cinereus* Meigen in parks 2, 3, and 10 (12.1, 13.6, and 10.4%) and *A. trivittatus* (Coquillett) in park 1 (2.9%).

Adult biting collections during 1972 and 1973 showed that individuals of the *Aedes communis* (DeGeer)-*A. trichurus* (Dyar) complex were the problem mosquitoes at North Higgins Lake Park while an identical sampling program conducted at Yankee Springs recreational area indicated that mosquitoes of the *A. stimulans* (Walker)-*A. fitchii* (Felt and Young) complex were responsible for biting problems there. As identification of adult females to species level was difficult, supplemental larval surveys were conducted during the 2-year study. Collections from North Higgins Lake consisted of *A. communis* and *A. trichurus* in a 2:1 ratio, respectively, while the larval samples from Yankee Springs were almost exclusively *A. fitchii*. Identification of these collections was aided by keys contained in Barr (1958) and Carpenter and LaCasse (1955).

Tables 2 and 3 show the results of the 2-year study on biting activity at the two parks. The highest activity for *A. communis-trichurus* occurred in late May and early June with a mean count for the 3 sites ≥ 20 . Biting collections were re-

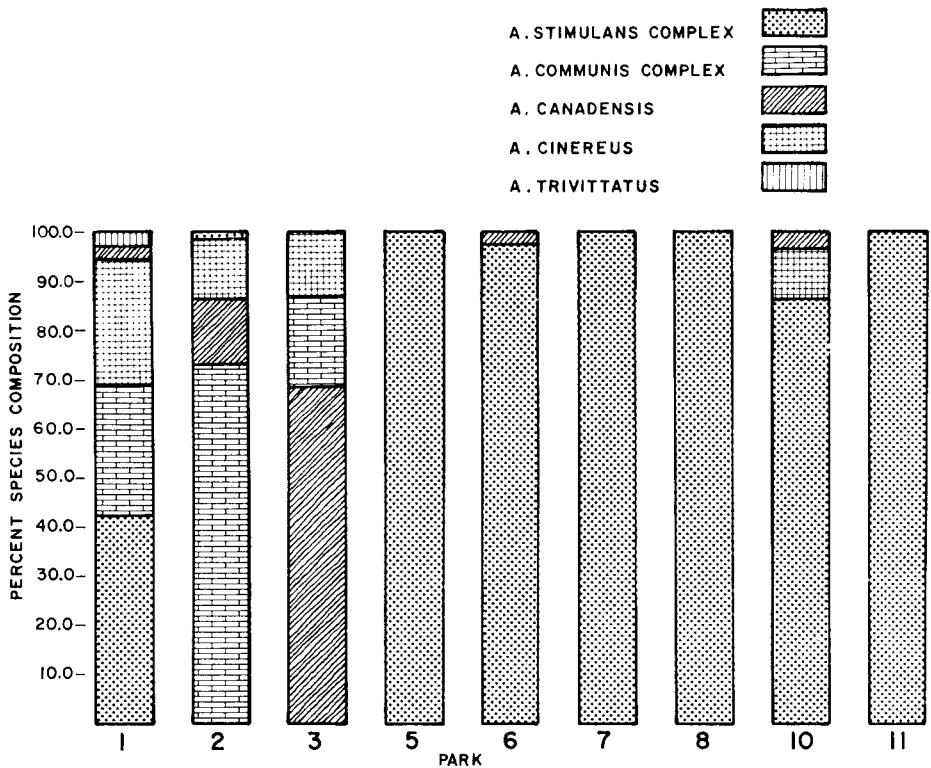


Fig. 2. Percent species composition of the *Aedes* snowpool mosquitoes identified from collections made in nine Michigan state park and recreational areas, 1971.

duced approximately 50% by the 4th sampling both years. A mean count of <10 mosquitoes was recorded during the July 6 sampling in 1972 while a similar level in 1973 occurred 3 weeks earlier, on June 14. Biting activity for this species complex for both years was essentially non-existent after the 3rd week in July. Other species identified from the biting collections from North Higgins Lake were *A. canadensis*, *A. triseriatus*, *A. stimulans* complex, *A. vexans* and *C. perturbans*. Of these only *A. canadensis* was consistently present in the collections beginning the 1st week in June and lasting through the July collections. The mean biting count for this species in 1972 ranged from 4.67 in the July 6 collections to 2.00 during the July 20 collecting period, while in 1973

the mean count ranged from 5.67 on July 5 to <1.00 on August 2. *C. perturbans* was collected in substantial numbers from only one site during 1972 and 1973. Individuals of this species appeared in the collections during the first week of July both years with the highest count of 14 for a 10-minute sampling trial recorded July 13, 1972 at the outdoor educational site. However, the species was never detected on a regular basis at any of the other sites. The other previously mentioned species were present so infrequently and in such small numbers that their contribution to the biting problem was considered minimal.

Table 3 shows the results of the 2-year sampling study at Yankee Springs recreational area for the *A. stimulans-fitchii*

Table 2. Biting activity of *Aedes communis-trichurus* complex at North Higgins Lake state park, 1972-1973.

Month/Day ^a	Sampling trial		Sample total ^b		\bar{x} biting count/10 min		S \bar{x}		
	1972	1973	1 week interval	1972	1973	1972	1973	1972	1973
May	25	24	1	81	68	27.00	22.67	2.646	2.186
	31	31	8	86	65	28.67	21.67	2.404	1.732
June	8	7	15	64	59	21.33	19.67	1.764	2.028
	15	14	22	29	24	9.67	8.00	1.453	1.000
	22	21	29	35	26	11.67	8.67	1.856	1.453
	29	28	36	31	29	10.33	9.67	0.882	1.856
July	6	5	43	19	16	6.33	5.33	0.333	0.333
	13	12	50	28	10	9.33	3.33	0.882	0.882
	20	19	57	5	..	1.67	...	0.667	...

^a Collections made at weekly intervals from time of adult emergence until mean biting count was $<10/10$ min. period for 2 successive weeks.

^b Total number of mosquitoes collected during 10-minute sampling periods at each of 3 public use sites.

complex. The adult population had completely emerged by the end of May 1972 and the mean biting count for 7 weekly sampling trials ranged from 66.33 mosquitoes on July 4 to 51.00 mosquitoes on July 18. During the last week in July and 1st week in August the mean biting count dropped to 35.67 and 31.67, respectively. During and after the 2nd week in August it was <10 mosquitoes. The biting activity of the *A. stimulans-fitchii* complex during 1973 was similar. Mean biting counts during the same time period ranged from (samples taken a day later

from the 1972 trials) 20.67 to 70.33. The mean biting count from July 19 to August 2 was above 20.00. During the sampling trials on August 9 and 16 it dropped to below 10. Other species identified from the biting collections were *A. canadensis*, *A. vexans*, *A. cinereus*, *A. communis* complex, *C. perturbans* and *Anopheles walkeri* Theobald. Of these, *A. canadensis* and *A. vexans* were consistently collected in large numbers from the 3 public use sites during 1972 and 1973. Although *A. canadensis* was collected in sampling trials 1 through 78 both years the mean biting

Table 3. Biting activity of *Aedes stimulans-fitchii* complex at Yankee Springs recreational area, 1972-1973.

Month/Day ^a	Sampling trial		Sample total ^b		\bar{x} biting count/10 min		S \bar{x}			
	1972	1973	1 week interval	1972	1973	1972	1973	1972	1973	
May	31	31	1	168	141	56.00	47.00	4.163	10.017	
June	6	7	8	181	175	60.33	58.33	4.631	8.212	
	13	14	15	190	199	63.33	68.67	3.283	7.311	
	20	21	22	189	195	63.00	65.00	3.055	7.056	
	27	28	29	185	211	61.67	70.33	3.844	8.413	
	July	4	5	36	199	201	66.33	67.00	4.177	7.371
July	11	12	43	176	157	58.67	52.33	8.110	10.493	
	18	19	50	153	62	51.00	20.67	6.028	2.603	
	25	26	57	107	71	35.67	23.67	8.090	2.667	
	Aug.	1	2	64	95	63	31.67	21.00	7.688	5.132
	8	9	71	29	25	9.67	8.33	0.667	2.028	
15	16	78	25	12	8.33	4.00	0.882	1.000		

^a Collections made at weekly intervals from time of adult emergence until mean biting count was $<10/10$ min. period for 2 successive weeks.

^b Total number of mosquitoes collected during 10 minute sampling periods at each of 3 public use sites.

count for the 3 sites never exceeded 10 mosquitoes. *A. vexans* was present from the 2nd week in June until the end of July both years with a high count of 8.33 recorded on June 28, 1973.

COMPARISON OF BITING ACTIVITY AND EFFECT ON RECREATION. Comparison of sample totals (total number of mosquitoes captured during 1 trial at the 3 public use sites) in Tables 2 and 3 show the difference in the level and duration of biting activity. The totals for *A. stimulans-fitchii* at Yankee Springs during trials 1-43 were twice the number and a 2-fold increase in duration of biting activity as compared with *A. communis-trichurus* at North Higgins Lake. Biting activity for both species complexes was regularly distributed among the 3 sites as indicated by the means and standard errors of biting count collections (Tables 2 and 3).

Preliminary observations on the effect of biting activity on human recreation were also carried out. When mean biting counts at North Higgins Lake during late May were ≥ 20 , park visitors avoided recreational sites located in forested regions (i.e., nature trails) and stayed in those localities that possessed good prevailing winds (lake fronts) and lacked a forest canopy (beach areas). When these counts were ≤ 10 during June the recreational sites in these forested areas were utilized by park visitors. Recreational activities at nature trail and outdoor educational areas in Yankee Springs were adversely affected by the biting activity of *A. stimulans-fitchii* mosquitoes until the 1st week in August when mean counts dropped to ≤ 20.00 mosquitoes. The biting annoyance at the nature trail became so intense during late June and July 1973 that the park naturalist cancelled planned recreational activity for this area, mainly group tours for the purpose of nature studies. Biting collections made during this time showed a mean count of approximately 70 mosquitoes. A high of 84 mosquitoes was

collected in a 10-minute period at the nature trail on June 28, 1973.

CONCLUSION. The intensity and duration of mosquito biting activity in the recreational areas studied varied with the species group present. While studies in 1971 indicated that the woodland pool group was the major mosquito problem in most Michigan parks (substantiated by the 1972 and 1973 studies) this cannot be taken to mean that other species also do not or will not pose a problem. As *C. perturbans* comprised the majority of the collections in parks 9 and 11 and *A. quadrimaculatus* was the most frequently collected mosquito in park 5, surveys should be conducted on an individual park basis before a pronouncement is made on the species responsible for the biting problem. The studies at Higgins Lake and Yankee Springs during 1972 and 1973 indicated that the intensity and duration of the problems were quite different. At North Higgins Lake populations of the *A. communis-trichurus* complex were relatively short lived while those of *A. stimulans-fitchii* at Yankee Springs were much higher and lived longer, suggesting that different control strategies are necessary for these 2 parks. Finally, the results of surveys in 1972 and 1973 indicate that when the mean biting counts were ≤ 10 mosquitoes park visitors would utilize recreational facilities located in forested areas while counts ≥ 20 mosquitoes markedly reduced their use. Mean counts of 60 to 70 mosquitoes caused cancellation of planned recreational activities.

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