THE DIEL ACTIVITY CYCLES OF *CULISETA MELANURA* (COQUILLETT) AND ALLIED MOSQUITOES[1]

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Knowledge regarding the diel[3] activity cycle of an arthropod vector of a disease is an important ecologic aspect in understanding the epidemiology of the disease. This fact was reiterated recently by a World Health Organization Study Group on arthropod-borne viruses (1).

Culiseta melanura (Coq.) is known to be an enzootic vector of eastern encephalitis. This species has been observed to bite man (2) and therefore may be involved in direct transmission of the disease to humans, but no detailed study on its diel activity cycle has been reported.

Mosquito collections obtained from light-traps (3, 4), mechanical sweep nets (4), or baited traps (5) operated continuously from one evening to the following morning do not indicate whether a species is most active during the twilight periods or during the night. Burbutis and Jobbins (3) reported that in New Jersey *C. melanura* and several other mosquito species usually entered diurnal resting boxes between 8 and 9 a.m., and in Massachusetts (6) swarms of these mosquitoes were observed on numerous occasions during the period from 1 hour before sunset until 1 hour after sunset. This paper re ports the results of our studies, conducte in Raynham, Massachusetts during 195 1959, and 1961, to obtain information o the diel periodicity of adult *C. melanur*

MATERIALS AND METHODS. The sever mosquito collecting techniques and tim intervals utilized for periodic collection to obtain data on the diel activity cycle are indicated in the figure.

The 1957 study was carried out in a bo type cedar-tree portion of Hockomoc Swamp. The mosquitoes that landed o the author were collected by aspirator du ing eight 15-minute periods beginning hour before sunset and continuing unt 1 hour after sunset (see figure).

Two types of studies to obtain data o mosquito periodicity were conducted du ing 1959. One of these utilized the sam techniques as the aforementioned 195 study, except that four individuals co lected mosquitoes simultaneously at fou different locations monthly during Jun July, and August. Each individual alwa collected at the same location. The fou collecting sites were: (1) within a bo type cedar swamp named "Pine Swamp (2) 0.1 mile from the swamp; (3) o mile from the swamp; (4) 2.0 miles fro the swamp. Twelve 15-minute collectin intervals were utilized in each trial, shown in the figure.

In the other 1959 study, mosquito co lections were obtained adjacent to Hock mock Swamp by means of four grackl baited traps, which were simultaneous operated while suspended from a slowl moving rotary, previously described (5 Once during July and again in Augu there were 8 collecting periods of varyin length when the traps were operated co tinuously for 24 hours.

Periodic collections of mosquitoes in th Pine Swamp location were obtained du

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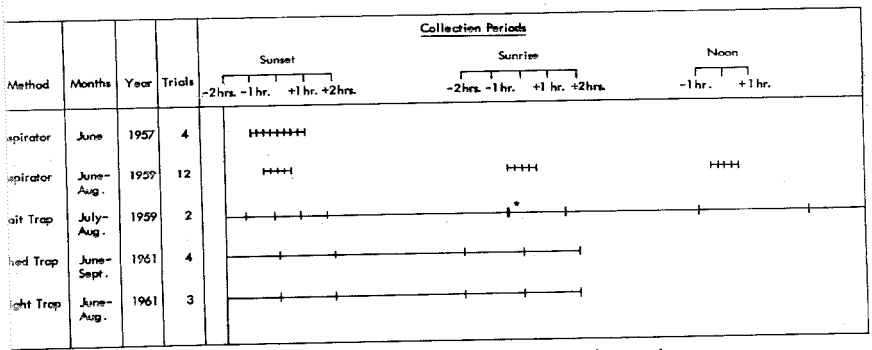
[3] Any twenty-four hour period.



Collections begun ½ hour before sunrise and run continuously for 24 hours.

; 1961 from shed-traps (7), and New sey type light-traps. The shed-trap lections were made monthly from June ough September, and the light-trap col- tions were made monthly from June ough August. Five trapping periods re used for each of the two methods e figure), but both methods were not ployed on the same night. The shed- p collections were obtained as the mos- itoes attempted to enter a chicken coop feed on roosting chickens. At the end each collecting period, the trap was noved and a new one was installed. Mosquitoes entering the light-traps were lected into chloroform killing jars. In eration, the traps were suspended from turning rotary, and collection was fa- tated by automatic timers that shut off e trap and started another at the end of h period.

Descriptive notes, of temperature and midity readings, were recorded during st of the mosquito collections made in se studies. Occasionally collections were continued due to adverse weather con- ions, and these data were disregarded purposes of this report. It is believed at weather conditions had little influence the conclusions regarding mosquito l activity cycles.

RESULTS. The data obtained on the diel ivity cycles of female *C. melanura* and e other mosquito species are summarized Table 1.

The average numbers of *C. melanura* collected per hour were significantly greater during the periods after sunset than during all other periods. All but 1 of the 359 *C. melanura* collected in 1959 were obtained during the hours between sunset and sunrise; in 1961, of the 259 obtained, only 17 were collected in the periods before sunset and after sunrise. In 1959, the collecting rates were similar during the second hour after sunset and during the long night period that followed. It was not determined whether the mosquitoes trapped during the latter period were obtained consistently throughout the night, or whether there were one or more periods of peak activity during the night. However, in 1961, the collection rates during the 2-hour period after sunset were significantly greater than during the long night period that followed.

Even though the collections in 1957 and 1959 were made in areas with relatively large populations of *C. melanura,* the total obtained by aspirator was only 31. Only 18 males of the species were collected, and they were taken in light-traps during the peak periods of activity of female *C. melanura.* For the periodic collections, grackle- or chicken-baited traps were the most effective for collecting this species.

Mansonia perturbans also were found to be most active after sunset and were rarely collected during daylight hours (Table 1). All of the *M. perturbans* were obtained in aspirator collections.

TABLE 1.—Average number of adult female mosquitoes collected per hour by several methods during selected time intervals at Raynham, Massachusetts.

Species	Collection method	Year	Trials	Average hourly collection rate during indicated periods												
				Sunset					Sunrise				Noon			
				2 hrs. before	1 hr. before	1 hr. after	2 hrs. after	Night	2 hrs. before	1 hr. before	1 hr. after	2 hrs. after	Fore-noon	1 hr. before	1 hr. after	After-noon
Aedes abserratus	Aspirator	1957	4	..	30	20	..	..	..	..	..	..	..	..	..	..
	Shed-Trap	1961	1	4	..	..	26	<1	8	..	..	2	..	..	..	..
A. canadensis	Aspirator	1957	4	..	33	14	..	..	..	..	..	..	..	..	..	..
	Aspirator	1959	12	..	115	137	..	..	..	95	115	..	..	17	11	..
A. cantator	Aspirator	1959	12	..	18	55	..	..	..	13	5	..	..	16	23	..
Culex salinarius	Aspirator	1959	12	..	35	46	..	..	..	85	109	..	..	1	1	..
	Bait-Trap	1959	2	0	0	20**	26	12	..	..	..	4*	<1	..	..	0
	Shed-Trap	1961	4	1	..	..	62	18	7	..	..	0	..	..	..	..
	Light-Trap	1961	3	0	..	..	3	<1	<1	..	..	0	..	..	..	..
Culiseta melanura	Bait-Trap	1959	2	0	0	30**	18	16	..	..	..	<1*	0	..	..	0
	Shed-Trap	1961	4	1	..	..	17	<1	1	..	..	<1	..	..	..	..
	Light-Trap	1961	3	<1	..	..	11	2	<1	..	..	<1	..	..	..	..
Mansonia perturbans	Aspirator	1957	4	..	1	51	..	..	..	..	..	..	..	..	..	..
	Aspirator	1959	12	..	3	33	..	..	..	19	10	..	..	0	2	..

* Collecting started less than ¼ hour before sunrise.
** Collecting started less than ½ hour before sunset.

Aedes abserratus, a spring-brood mosuito, was collected only during June in umbers sufficiently large to permit comarisons of activity cycles. This species so was most active during the evening epuscular periods (Table 1). During)57, aspirator collections of *A. abserratus* ere high both before and after sunset; uring 1961, the shed-trap rate was defitely higher after sunset.

Aedes cantator was active throughout e day, but the highest rate was observed uring the evening crepuscular period llowing sunset (Table 1). *A. canadensis* so was active during the day, but there ere major peaks of activity around sunt and again near sunrise. The midday pirator collections of *A. cantator* and *canadensis* were significantly greater an for any other species observed in is study.

Culex salinarius were collected in greatt numbers during the morning and ening twilight periods (Table 1). In e 1959 aspirator collections the peak tivity occurred during the morning pe)ds; during the 1961 trap collections, wever, the peak activity occurred during e 2 hours after sunset. Very low rates ere obtained during daylight hours, but 1959 a considerable amount of activity curred during the night periods.

The summer drought (8) of 1957 reted in greatly reduced mosquito popuions after June. Of the 678 mosquitoes lected during 10 trials, 645 (95 percent) re obtained during the four June eveig collections, 22 were obtained during three July collections, and only 11 were tained during the three August collecns. The 1957 data in Table 1 are enly from the June collections.

DISCUSSION. Mosquito light-traps and d-baited traps were found suitable for taining periodic collections of sufficient mbers of *C. melanura* to indicate the cies' diel activity cycles. When humans re used as an attractant, the species was en only occasionally by aspirator in ding collections.

The collections of *C. melanura* indicate t most of the activity occurred during the evening twilight period. There was also considerable night activity of the species in 1959, but very little was detected during 1961. The reason for this difference is not known. It is noteworthy that the period of peak *C. melanura* activity in both the light-traps and the shed-traps was during the same crepuscular period, and this was a period in which the light-trap might not be expected to be as attractive as during the darker portions of the night. Since the light-trap in our study was located within a swamp site, there was no other source of artificial light to compete with it. The shed-trap and light-trap collections were obtained on different weeks of the month so they would not compete with each other.

In the previously mentioned study on swarming of *C. melanura* (6), it was noted that the swarms of males formed within ± 5 minutes of sunset and continued for at least 1 hour. Since the 18 males obtained in this study were collected after sunset, it seems likely that their activity cycle coincides with that of the females.

Bates (9) indicated that, in general, the time of biting activity is a good indication of the time of other activities of a given mosquito species. McClelland (10), in his studies of *Aedes aegypti* in East Africa, also noted a close correspondence between biting activity and flight activity; Beadle (11) made similar observations in his studies of *Culex tarsalis* in the United States. Our observations that the peak hours of *C. melanura* activity occur soon after sunset provide further insight into the species' role as an enzootic vector, rather than an epidemic vector, of eastern encephalitis in Massachusetts. This period coincides with the time when wild birds, its preferred host (5), nest or roost for the night and are easy prey for its feeding, and when there is little likelihood of contact with humans in its swamp habitat. Thus, its diel periodicity pattern may contribute toward its importance as an enzootic vector of eastern encephalitis and to its apparent unimportance as an epidemic vector.

None of the other species collected in

sufficient numbers to permit evaluation showed activity cycles as restricted to the evening periods as *C. melanura. M. perturbans, C. salinarius, A. abserratus, A. canadensis,* and *A. cantator,* although usually most active during the evening crepuscular periods, on occasion showed a considerable amount of morning activity. Furthermore, diurnal collections of *A. canadensis* and *A. cantator* were readily obtained.

The effect of a summer drought upon the mosquito populations of a freshwater swamp was reflected by the data obtained in 1957. Following the spring emergence of *A. abserratus, A. canadensis,* and *M. perturbans,* there was a sharp decline in the mosquito collection rates. Furthermore, the usual summer populations of other *Aedes* species and of *Culex* species did not develop.

SUMMARY. The diel activity cycles of adult *Culiseta melanura* in Raynham, Massachusetts were determined upon the basis of periodic bait-trap, shed-trap, and light-trap collections. The 2-hour period following sunset was the period of peak activity of *C. melanura,* a time that would seem to facilitate feeding on the preferred hosts, wild birds, and would reduce the opportunity for feeding on man in its swamp habitat. The activity peaks of *Aedes abserratus, A. cantator,* and *Mansonia perturbans* occurred during the evening crepuscular periods; whereas, activity peaks of *A. canadensis* and *C. salinarius* occurred both in the morning and evening periods. Considerable diurnal activity w noted only for *A. canadensis* and *A. cant tor.*

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Those who have received a questionnaire from the National Mosquito Control-F and Wildlife Management Coordination Committee, requesting figures on the ki and amounts of insecticide being used for mosquito control, are reminded that t information should be forwarded without delay.