airborne insects which automatically segregates the catch into successive hourly samples. Ann. Appl. Biol. 37:80–89.
Koch, H. G., R. C. Axtell and G. R. Baughman. 1977. A suction trap for hourly sampling of coastal biting flies. Mosq. News 37:674–680.
McIver, S. B., T. J. Wilkes and M. T. Gillies. 1980. Attraction to mammals of male *Mansonia (Mansonioides)* (Diptera: Culicidae). Bull. Entomol. Res. 70:11–16.
Service, M. W. 1976. Mosquito ecology: field sampling methods. 583 pp., Liverpool. Applied Science Publishers.
Smith, S. M., D. M. Davies and V. I. Golini. 1970. A contribution to the bionomics of the Tabanidae (Diptera) of Algonquin Park, Ontario: seasonal distribution, habitat preferences, and biting records. Can. Entomol. 102:1461–1473.

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THE HOST SEEKING ACTIVITY OF *CULEX SALINARIUS*[1, 2]

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ABSTRACT. Host seeking in *Culex salinarius* was studied at 2 locations in New Jersey during 1977 and 1978. The results at both sites indicated that the species was most active within 2 hr after sunset. Sampling with pigeon traps and a standard sweep net showed a significant reduction in host seeking activity during the remainder of the night, and no increase in activity was noted prior to dawn.

The effects of environmental conditions and the physiological age of the population were statistically analyzed to determine the degree of influence they exerted on the host-seeking cycle. Elevated temperatures increased the number collected slightly, but relative humidity, cloud cover, wind, and parous rate did not affect the basic pattern. The information obtained from the study demonstrated that control measures for adult *Cx. salinarius* might be more effective if applied during the evening hours.

INTRODUCTION

Although mosquito control is generally most effective when directed against the larval stages, adult abatement is sometimes required to alleviate a severe nuisance situation or to control a potential disease problem. During the era of chlorinated hydrocarbons, spray timing was not critical because the mosquitoes would eventually make contact with these long-lived pesticides. With the advent of organophosphate pesticides that break down rapidly in the environment, however, the chemical must be dispensed when the mosquitoes are most active to facilitate maximum kill. To accomplish this effectively, knowledge of the peak flight time for a species must be thoroughly understood.

Results from activity studies carried out with the nuisance mosquito *Culex salinarius* Coquillett are inconsistent. Although Murphey and Darsie (1962) reported that the species is most abundant just after dusk, other researchers indicate a predawn activity surge in addition to that seen in the evening (Nayar and

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Sauerman 1974, Carroll and Bourg 1977). Research conducted with other mosquito species supports the concept of bimodal activity peaks (Nayar and Sauerman 1974, Barnard and Mulla 1977, Ebsary and Crans 1977). The present study was undertaken to clarify the activity cycle for *Cx. salinarius*.

MATERIALS AND METHODS

Culex salinarius populations were sampled in 2 areas during the summers of 1977 and 1978. The Barnegat Township site in Ocean County bordered a freshwater impoundment that produced large numbers of *Cx. salinarius*. The Lyndhurst site in Bergen County was heavily urbanized and, according to light trap data, produced a mixed population of *Culex* mosquitoes, including *Cx. pipiens* Linnaeus, *Cx. restuans* Theobald, and *Cx. salinarius*. Sampling was conducted throughout a total of 4 nights in each area during the time of the study.

Two trapping methods were employed to monitor the host-seeking activity of *Cx. salinarius*. The first technique made use of the pigeon trap (Ehrenberg 1966), a device that is highly selective for *Culex* species and captures the mosquitoes gently enough to permit accurate identification (Downing and Crans 1977). The removable sleeves on these traps were changed at hourly intervals from sunset until 1 hr after sunrise. The catch was anesthetized with chloroform and stored in labeled, 4-dram, snap-cap vials at −70°C until processing was possible.

A standard sweep net was used to collect mosquitoes seeking a blood meal from humans. A person would walk to a specified location, wait 1 minute, and then sweep the air about the body for 5 minutes. The sampling was repeated every 30 minutes for 3 hours after sunset and then hourly for the duration of the night.

The effect of physiological age on the activity cycle was determined by making ovarian dissections for each hourly sample. The mosquitoes were classified as parous or nulliparous (Detinova 1962), and a chi-square analysis was performed on the data to detect any significant changes in the age composition of the population throughout the night.

In addition to time after sunset, certain environmental conditions were monitored to determine their role in the feeding cycle of *Cx. salinarius*. Temperature and precipitation information was recorded at the site, and relative humidity, wind speed, and cloud cover readings were obtained from nearby weather stations. The influence of these factors on flight activity was shown by subjecting the trap data to a square root transformation and then conducting an analysis of variance.

RESULTS AND DISCUSSION

Data obtained from the pigeon trap collections show that most of the *Cx. salinarius* activity in Ocean County took place during the first 2 hours after sunset (Figure 1). The number captured for the remainder of the night was greatly reduced, with a slight secondary peak being evident at 7 hr postsunset. No significant increase was seen just before sunrise. Although populations in Bergen County were smaller, a similar pattern of activity was illustrated by the pigeon traps in this area.

Data from the Ocean County sweep collections indicate that the greatest proportion of host-seeking by *Cx. salinarius* took place during the first 30–60 minutes after sunset (Figure 2). With the exception of a small increase in activity at 5 hr after sunset, the Bergen County cycle was much the same.

Results from the analysis of variance demonstrate that host seeking activity in *Cx. salinarius* differed substantially depending on the date and the hour in which a collection was made. Since mosquito population levels change greatly over extended periods of time, the variations from one date to another are not unexpected. The effect of time after sun-

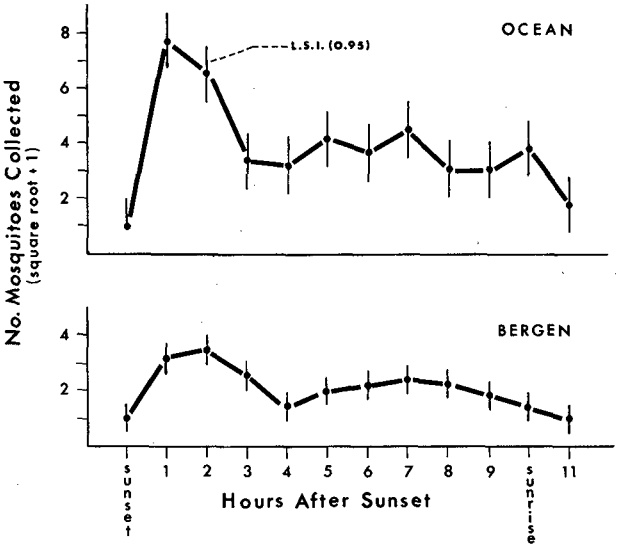

Fig. 1. The average number of *Culex salinarius* collected in pigeon traps from sunset to sunrise at 2 sites in Ocean and Bergen Counties in New Jersey.

set, however, followed a consistent pattern that was independent of both site and date. This analysis also indicated that temperature became a factor of slight significance when the effect of hour was removed.

The physiological age of the mosquitoes did not appear to influence the time at which they sought a host. The chi-square test demonstrated that the parous rate of the population did not change significantly throughout the night and was similar in both sweep net and pigeon trap samples.

The results of this study are in agreement with the findings of Murphey and Darsie (1962), indicating that female *Cx. salinarius* host seek primarily during the first 2 or 3 hours after sunset. Although the species will continue to search for a blood meal in smaller numbers throughout the remainder of the night, a predawn resurgence of this behavior was not seen.

In studies that did not employ attraction based collection methods, a predawn activity increase has been detected (Nayar and Sauerman 1974; Carroll and Bourg 1977). There is a possibility that the early morning peak may be the result of *Cx. salinarius* engaged in activities other than host seeking such as mating, egg laying or a return to resting sites at sunrise. Based on the findings of the current research,

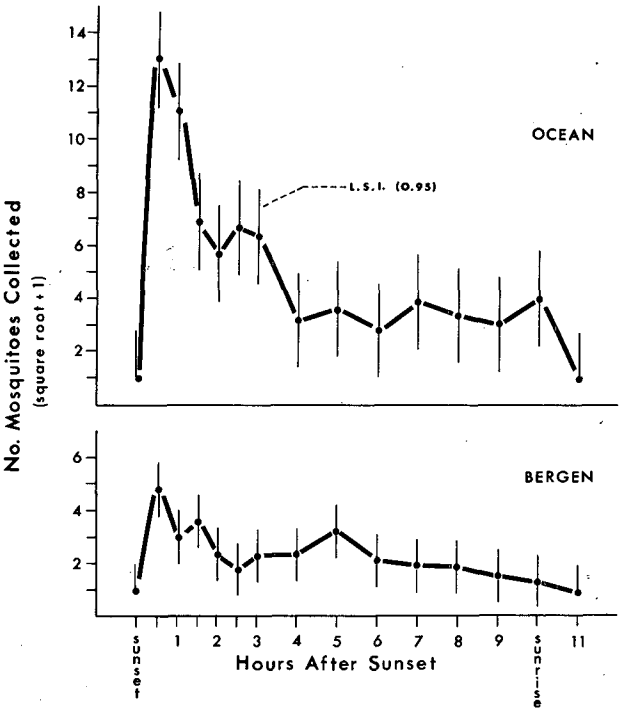

Fig. 2. The average number of *Culex salinarius* collected in 5-minute-sweep net samples from sunset to sunrise in Ocean and Bergen Counties in New Jersey.

however, dusk is apparently the most suitable time to apply pesticides for controlling adults of the species.

References Cited

Barnard, D. R. and M. S. Mulla. 1977. Diel periodicity of blood feeding in the mosquito *Culiseta melanura* in the Coachella Valley of southern California. Mosq. News 37:669–673.

Carroll, M. K. and J. A. Bourg. 1977. The night-time flight activity and relative abundance of fifteen species of Louisiana mosquitoes. Mosq. News 37:661–664.

Detinova, T. S. 1962. Age-grouping methods

in Diptera of medical importance with special reference to some vectors of malaria. W.H.O. Monogr. Ser. 47:1–216.
Downing, J. D. and W. J. Crans. 1977. The Ehrenberg pigeon trap as a sampler of *Culex* mosquitoes for St. Louis encephalitis surveillance. Mosq. News 37:48–53.
Ebsary, B. A. and W. J. Crans. 1977. The biting activity of *Aedes sollicitans* in New Jersey. Mosq. News 37:721–724.
Ehrenberg, H. A. 1966. Some comparisons of a pigeon-baited trap with a New Jersey light trap. Proc. N. J. Mosq. Exterm. Assoc. 53:175–182.
Murphey, F. J. and R. F. Darsie. 1962. Studies on the bionomics of *Culex salinarius* Coquillett: I. Observations on the crepuscular and nocturnal activities of adult females. Mosq. News 22:162–171.
Nayar, J. K. and D. M. Sauerman. 1974. Circadian rhythms in Florida mosquitoes. In Chronobiology, ed. by L. E. Sheving, F. Halberg and J. E. Pauly. Igaku Shoin Co., Tokyo. 784 pp.

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LOCAL DISTRIBUTION OF *AEDES TRISERIATUS* (DIPTERA:CULICIDAE) AT THE BALTIMORE ZOO[1]

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ABSTRACT. Field studies on the tree hole mosquito, *Aedes triseriatus* were conducted at the Baltimore Zoo. Through larval surveys and ovitrap sampling the oviposition patterns, seasonal dynamics and dispersal of *Ae. triseriatus* were studied in 4 biotopes: forest, field, lawn, and penguin exhibit. Natural sources of this species existed exclusively in the forest and were represented by 164 beech tree holes per hectare. Ovitrap sampling indicated that *Ae. triseriatus* was not strictly confined to the forest where natural development sites exist. Oviposition activity was highest in the beech forest, was less common in the lawn and open field biotopes and was rare at the penguin exhibit.

INTRODUCTION

Aedes triseriatus (Say) is widely distributed east of the Rocky Mountains in the U.S. (Zabortink 1972). It is the most abundant species developing in tree holes in North America and it also develops in tires and other artificial containers in urban habitats (Jenkins and Carpenter 1946). In midwestern U.S. *Ae. triseriatus* is the principal biological vector of La Crosse encephalitis virus (Watts et al. 1972, 1973; Grimstad et al. 1977). This species is also capable of experimentally transmitting eastern equine encephalitis (Chamberlain and Sudia 1961), and is susceptible to dog heartworm *Dirofilaria immitis*) (Intermill 1973) and several species of avian malaria (Huff 1965). Despite its potential as a vector of disease, relatively little is known about the factors affecting the distribution and dispersal of this mosquito.

Monitoring field populations of this species is difficult. Adults are not generally attracted to light traps or bait traps (Loor and DeFoliart 1969). Because tree

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