COMPARISON OF MORNING AND EVENING CAPTURES OF ADULT FEMALE *ANOPHELES ALBIMANUS* FROM STABLES IN EL SALVADOR

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ABSTRACT. In stables in El Salvador, Central America, 12.7% more adult *Anopheles albimanus* Wiedemann were captured during the early morning than during the evening. Also, oviposition from the morning-collected females was 57.4% greater than from those collected in the evening. There was no apparent difference either in the natural fertility of the 2 collections or in the sterility induced by a sterile-male release experiment. Logistical problems involving personnel work schedules and use of vehicles were eliminated by the early morning collections.

INTRODUCTION

When one wishes to study the behavior or dynamics of a natural population of insects, to collect specimens for initiating laboratory colonies, or to determine the impact of control programs, an efficient method of capturing a representative sample of the native population is essential. Evaluations of natural mosquito populations usually involve assays of larval or pupal breeding sites or the capture of adults, and numerous methods of increasing the efficiency of these surveys have been described.

Since *Anopheles albimanus* Wiedemann is the prime vector of malaria in Central America, there has been a special effort to study the biology of this species and to determine the interaction between the adult mosquitoes and human or animal hosts. For example, a thoroughly documented manuscript on the behavior of *Anopheles* spp. in Panama was published by Zetek (1915) in which he described several methods of capturing adults that are still in use today, though somewhat modified. All of these involved collections during a peak of flight activity, from dusk to early nighttime, a practice in common use to the present. However, Breeland (1972a) included diurnal collections from natural resting sites in an evaluation of methods measuring anopheline densities by use of adult capture techniques. Also, in a second paper (1972b) he determined the 24-hr cycle of activity of adults at natural sites and showed that both sexes could be collected from resting locations. When he subsequently compared this collection method with other more commonly used techniques, he found that light traps operated all night, evening captures from stables, and peridomiciliary human-bait captures were all superior to collections from diurnal resting sites (Breeland 1972c). Hobbs (1973) also studied the population dynamics of *An. albimanus* by utilizing light traps, human-bait collections, and captures from stables. Again, the stable collections were made after dark (1900–2000 hr) and the biting captures (human bait) for 1 hr after sunset (1830–1945 hr); also the light traps were operated from sunset to sunrise. In addition, studies of adult densities have been conducted with various types of light traps (Wilton 1975a, b) for different periods between dusk and dawn.

During releases of chemosterilized male *An. albimanus* in El Salvador, Lofgren et al. (1974) captured adult females from stables and from human bait for assay of the level of field sterility achieved. The human-bait collections were made from 1745 to 1830 hr, and the stable captures were routinely conducted from 2000 to 2200 hr. However, a few stable collections were made during a 1-hr period in the mornings to obtain additional adults for evaluation. Since

these collections were only used to augment the number of females used for sterility assays, they were done only occasionally, and no effort was made to record the numbers collected or any differences in results.

Our present program in El Salvador is also involved with evaluation of the sterile male release technique for control of *An. albimanus,* and the collections of indigenous females are important in determining the abundance and reproductive potential of the treated population. Initially, adults were collected from stables in the evening according to time-honored custom. Then changes in the release techniques made it possible to complete all the field work except the adult captures during daylight hours. An effort was therefore made to determine whether this task could be accomplished early in the day.

MATERIALS AND METHODS

The diurnal collections of adult *An. albimanus* were made for a period of 1 man-hr at the stables, and were completed between 0800 and 1000 hr. Adults were captured individually with a mouth aspirator and placed in 15 × 15 × 24 cm gauze-covered wire cages (200 adults/cage). The stocked cages were then supplied with a cotton pad soaked in 10% sugar water as a food source, placed in an expanded-foam thermal chest, and covered with a large, damp piece of cotton to maintain humidity. These chests were left in the work vehicles throughout the day while other duties were being performed. Between 1500 and 1600 hr, the cages were transported to the laboratory, supplied with fresh sugar water pads, and maintained at a temperature of 26±2°C and a relative humidity of over 70%. Two days later the surviving females were placed individually into 5-dr plastic vials containing a few ml of infused water as an oviposition medium. Five days later (2 oviposition and 3 to obtain maximum hatch), the vials were examined, and oviposition and hatch data were recorded.

Evening collections were made after dark (between 1845 and 2020 hr) at each stable where a morning collection had been made that day. Capture and transport were identical to that used earlier, except that the cages were returned to the laboratory immediately, usually by 2100 hr. Also, the next morning these mosquitoes were offered a blood meal from a rabbit to assure that they had fed. Further handling and assay were identical to those used for the morning captures.

All collections used in the comparison were from 7 stables, scattered throughout a diverse agricultural area and separated by as much as 9 km. Nevertheless, it was sometimes possible to manage more than 1 pair of collections a day. Prior to this comparison of adult captures made in the morning and evening, the routine for adult collections had consisted of weekly captures (1 man-hr) from each of 18 stables. However, it was so difficult to schedule 2 collections the same day (morning and evening) from all the sites that 3 were chosen from an area where a sterile male release experiment was in progress, and 4 were chosen from outside of this area. To determine whether the capture methods had any effect upon the oviposition or percent sterility of adult females collected in the two areas, we evaluated the data from each area separately.

The methods of capturing, transporting, and maintaining the adult females had been used routinely for more than a year. During that time, these methods had provided an average survival of 88.7% of captured females that were placed in vials, a technique used to determine sterility by Lofgren et al. (1974) during an earlier experiment with *An. albimanus.*

RESULTS AND DISCUSSION

The number of adults collected each of the 6 weeks of the test is reported in Table 1 with the number of collections.

Plainly, morning captures were feasible, and they also produced larger collections of adult females than did the evening captures. In fact, with the same 60 man-hr of collection, 12.7% more females were captured in the morning. The only exception occurred during the 3rd week of the test when captures were made at 2 usually highly productive stables the morning after a heavy rain with strong winds. These conditions could have accounted for the smaller early morning collections (the adults were less active during the night) and also the larger numbers captured that evening when more females were seeking a blood meal.

There was a dramatic difference in the rates of oviposition of the females collected at the 2 times (Table 1). Those collected in the morning oviposited at an average rate of 82.8% compared with a rate of only 52.6% for those collected in the evening captures, an actual increase of 57.4%. Furthermore, the rate of oviposition was less variable in females from morning collections.

The wide variation in the oviposition rates of evening-captured females throughout the test probably indicated that there was some biological reason for the difference between populations. However, other than the time of capture, there were only 2 differences in handling that could explain it. The most important of these was that the females captured in the morning were almost always fully engorged and were resting in the stables while digesting their blood meal; those captured in the evening had apparently entered the stable and had not always found a host. It was for this reason that the evening captures were permitted to feed on rabbits in the laboratory the next morning. Obviously this method of making certain that the females had an opportunity to become gravid was less effective than collecting females that had fed naturally.

The second difference was that the morning collections were held in the transport containers for as long as 6½ hr before they were returned to the laboratory; the evening collections were held a maximum of 2 hr. Thus the containers with morning captures were subject to higher temperatures and more movement while the vehicles were driven over rough terrain. We had expected the delay to be detrimental to the morning collections. There was a survival rate of 96.5% for the evening collections until they were placed in vials, and survival of the morning captures was only slightly reduced to 91.8%. This higher mortality was of little consequence in view of the greater number of adults captured and the

Table 1. Morning and evening captures of adult female *Anopheles albimanus* from stables during a period of 6 weeks in El Salvador.[a]

Week	No. of collections	No. adults collected per man-hr		Percent oviposition[b]		Percent sterility[c]	
		Morning	Evening	Morning	Evening	Morning	Evening
1	7	81	76	83.3	62.3	4.1	2.6
2	10	166	117	84.2	34.9	11.1	18.2
3	13	273	409	87.4	48.4	12.9	14.0
4	11	324	200	77.9	53.9	9.6	7.9
5	11	197	190	80.2	68.4	20.3	18.5
6	8	209	98	84.0	47.8	5.7	11.6
Avg.	10	208	182	82.8	52.6	10.6	12.2

[a] Morning captures were made between 0800 and 1000 hr; evening captures were made between 1845 and 2020 hr of the same day.

[b] Percent oviposition is based upon the number of live females put into vials.

[c] Percent sterility is reported only for those females that oviposited.

higher rate of oviposition of the morning collections. Nevertheless, it was later possible to return the morning captures to the laboratory before 1300 hr so as to decrease the time spent in the field vehicles.

The sterility observed among the field-collected females that oviposited in vials (Table 1) indicates an average difference of only 1.6% between morning and evening collections. In view of the greater numbers collected and the higher rate of oviposition, it may be that the morning capture data were actually more reliable. The results shown in Table 2 verify that adult females collected from the natural population for evaluation of sterility differed little in this regard (about 2%) between those collected in the morning and those captured in the evening. However, when induced sterility is determined (level of sterility in treatment area minus natural level in control area), the values are almost identical (10.2–10.4) for morning and evening collections.

Although the use of light traps, collections from human bait, or collections from natural resting sites can be helpful when one is determining densities of adult *An. albimanus*, we have found that captures from stables when mammalian hosts (mostly cattle) are present offer an efficient method of obtaining large numbers of healthy adult females for biological evaluations. Now we find that making captures during morning hours allows us to use available manpower more efficiently and thus more economically; it permits better utilization of vehicles and equipment; it has improved employee morale and has gained better acceptance of the program by local inhabitants.

Table 2. Percent sterility of female *Anopheles albimanus* captured during morning and evening hours from within or outside a sterile-male release test area.

	Morning		Evening	
Week	Inside release area	Outside release area	Inside release area	Outside release area
1	4.1	0.0	2.6	0.0
2	11.3	9.1	21.9	0.0
3	29.5	0.0	14.4	8.3
4	10.7	4.9	11.8	2.6
5[a]	23.7	0.0	39.5	8.6
6[a]	5.2	8.3	5.9	15.4
Avg.	14.1	3.7	16.0	5.8

[a] During week 5 the sterile male release area was changed, which affected sterility assays for week 6.

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