EVALUATION OF THE CDC GRAVID TRAP FOR THE SURVEILLANCE OF ST. LOUIS ENCEPHALITIS VECTORS IN MEMPHIS, TENNESSEE

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ABSTRACT. Collections with CDC Gravid Mosquito Traps on 954 trap-nights from May through September 1983 are compared to 2,608 concurrent resting site collections made in the same area of Memphis, Tennessee. Gravid Traps yielded 88 times more *Culex* per collection and 96 times more *Culex* per man hour. The total Gravid Trap catch was 135,724 mosquitoes, 99%of which were either *Culex pipiens* or *Cx. restuans*, whereas these species comprised only 63% of the 6,613 mosquitoes collected from resting sites. Gravid Traps also collected significant numbers of *Aedes aegypti* and *Ae. triseriatus*. On most nights, more than 95% of mosquitoes in the Gravid Trap catch were gravid females. These results demonstrate that the trap is an effective and efficient device for collecting several important vector species. The preponderance of gravid mosquitoes should enhance the probability of encountering pathogens acquired by blood-feeding.

INTRODUCTION

The CDC Gravid Mosquito Trap is a portable, battery powered device which was designed to collect gravid *Culex* mosquitoes (Reiter 1983). It was developed to replace resting site collections with a simpler and less subjective procedure for the surveillance of St. Louis encephalitis (SLE) vectors. In this paper we present a comparison of Gravid Trap collections made from May through September, 1983, with routine resting site collections made in the same area of Memphis, Tennessee, during the same period.

MATERIALS AND METHODS

Gravid Traps were operated once or twice weekly at 22 sites in a 26 km^2 sector of west-central Memphis, an area with a history of SLE in humans (Levy et al. 1978). These sites included backyards, industrial premises, cemeteries and wasteland. Sixty similar sites in other parts of the city were sampled on a less regular basis. Traps were set according to the procedure described by Reiter (1983). Oviposition attractant was produced as described by Reiter (1986).

Weekly resting site collections were made by hand aspirator[3] (Hausherr's Machine Works, Toms River, NJ 08753) at 89 sites in the same area. These sites, mostly storm culverts and other underground shelters, have been sampled on a weekly basis by the Memphis and Shelby County Health Department (MSCHD) since 1974. The method was originally chosen because it yielded much larger numbers of *Culex* mosquitoes than could be collected with CO_2-baited light-traps or chick-baited cone-traps (D. B. Francy, unpublished data). The sampling routine was not strictly defined because of great variation in the structure and form of the sites. The collector simply inspected each site at a convenient pace, endeavoring to maintain week-by-week uniformity in his visits.

A rapid count of the catch at the laboratory provided surveillance data for the control operations of the Health Department, after which the specimens were placed in low temperature storage (−60°C or lower) and eventually shipped to the Division of Vector-Borne Viral Diseases, Center for Infectious Diseases, CDC, in Ft. Collins, CO, for identification and virus testing. The same procedure was used for the Gravid Trap collections.

RESULTS AND DISCUSSION

A total of 135,724 mosquitoes were collected by Gravid Traps in 954 trap-nights (142.3 mosquitoes/trap-night). In the same period, 6,613 mosquitoes were collected in 2,608 resting site collections (2.5 mosquitoes/site-visit).

Mosquitoes collected over the entire season by the two methods are compared by species in Table 1. In the Gravid Trap catch, 99% (134,150 mosquitoes) were species considered to be important vectors of SLE (Bowen and Francy 1980). By contrast, only 63% (4,164 mosquitoes) of the smaller collection from the resting sites were in this category. The Gravid Trap collected 1,574 mosquitoes of other species, of which 236 (15%) were *Aedes aegypti* (Linn.), and 350 (22%) were *Aedes triseriatus* Say s.l., both

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[3] The use of trade names or commercial sources is for identification only and does not constitute endorsement by the Public Health Service or by the U. S. Department of Health and Human Services.

Table 1. Gravid Trap and resting site collections, May through September, 1983, in Memphis, Tennessee.

Species	Gravid traps	Resting sites
Aedes species (not identifiable)	6	
Ae. aegypti	236	1
Ae. albopictus	1	
Ae. canadensis	63	2
Ae. hendersoni	6	
Ae. infirmatus	1	
Ae. sticticus	5	38
Ae. triseriatus	93	3
Ae. vexans	41	124
Ae, triseriatus or *hendersoni*	251	2
Anopheles species (not identifiable)	1	
An. barberi	7	
An. crucians	1	
An. punctipennis	21	3
An. quadrimaculatus	79	15
Culex erraticus	544	2,170
Cx. peccator	8	2
**Cx. pipiens* s.l.	58,860	2,605
**Cx. restuans*	26,821	1,217
**Cx. pipiens/restuans* (not identifiable to species)	48,391	323
**Cx. salinarius*	73	17
**Cx. tarsalis*	5	2
Cx. territans	96	70
Culiseta inornata	26	3
Orthopodomyia species (not identifiable)	16	
Or. signifera	3	
Psorophora species (not identifiable)	4	
Ps. colombiae		2
Ps. ferox	56	14
Uranotaenia sapphirina	9	
Total	135,724	6,613

* Species considered to be vectors of St. Louis encephalitis (Bowen and Francy 1980).

important vectors of other arboviral diseases. The resting site collections yielded 2,449 mosquitoes of other species, but these included only one *Ae. aegypti* and 5 (0.2%) *Ae. triseriatus* s.l. Lastly, the Gravid Trap yielded one specimen of *Aedes albopictus* Skuse, the first adult specimen of this Asian species recorded east of the Hawaiian Islands (Reiter and Darsie 1984).

Gravid Traps collected mosquitoes on every trap-night from May through September, but two-thirds of all visits to resting sites did not yield any mosquitoes at all. This disparity was particularly evident in the spring and early summer. For example, in the last week of May, 21 trap-nights yielded 5,459 mosquitoes (260.0 per trap; S.D. = 171.0, range 50–797, median = 225). In contrast, in the same period, mosquitoes were found in only 18 out of 83 resting sites visited (21.7%), with a total catch of 145.

Gravid Traps gave a good indication of the activity of mosquito populations in their vicinity, but this was definitely not the case with resting site collections. For example, at one site, the Gravid Trap catch rose to more than 1,000 *Culex* per night in mid-July, but simultaneous collections in a culvert, 150 m away, yielded no mosquitoes on three successive visits. Inspection of the area revealed a very large breeding pool in the basement of an abandoned grain mill, midway between the two collection sites. This potentially dangerous source of vectors, adjacent to a low income residential area with a history of SLE in humans, would not have been detected on the evidence of the resting site collections.

The Gravid Traps functioned well in any location, provided the collecting net was shaded from direct sunlight. The ease of selecting collecting sites was in marked contrast to the problem of finding suitable resting sites for manual collection. The use of a standardized attractant (Reiter 1986) was definitely preferable to the subjective nature of the manual collections, which are clearly dependent on the diligence, visual acuity and physical condition of the operator.

Setting and collecting the Gravid Traps involved less time and effort than the arduous routine of collecting mosquitoes from resting sites. One operator could easily service 20–30 traps per day, compared to 8–10 resting sites. Moreover, the Gravid Trap was considerably more efficient than resting-site collections, yielding 87.9 times as many *Culex* mosquitoes per collection, 95.9 times as many *Culex* per man-hour (Table 2).

The number of trap-failures was not recorded, but was less than 5%. Traps were not set when heavy rainfall was expected because experience indicated that oviposition is inhib-

Table 2. Productivity of Gravid Trap and resting site collections, May through September, 1983, in Memphis, Tennessee.

	Gravid traps	Resting sites
Number of collections (Trap nights or resting-site visits)	954	2,608
Man hours*	318**	950***
Total *Culex* (SLE vectors only)	134,150	4,164
Culex per collection	140.6	1.6
Culex per man-hour	421.9	4.4

* Includes time for packing and dispatching, but not time spent on identification.

** Estimated figure based on 0.33 hours per trap.

*** Estimated figure based on time sheets.

ited during such weather. Most failures were due to damage by animals, probably dogs or other mammals, and ants were occasionally a problem. Strong winds upset traps in very exposed situations. One trap was stolen, one was lost in flash flooding, and batteries were removed on four occasions.

As would be expected, female mosquitoes were predominant in the Gravid Trap collections. Routine dissections were not made, but oviposition studies on sample collections indicated that at least 95% were gravid. Small numbers of males were collected at some sites. Occasionally, males comprised at least 50% of the catch; this seemed to occur when the overall catch was relatively high, and may have been associated with close proximity of an emergence site.

On most mornings, 80–95% of the mosquitoes in the Gravid Traps were alive and in good condition. Nevertheless, because the submedian scutal scales were absent in many specimens, *Culex pipiens* Linn. s.l. could not be distinguished from *Culex restuans* Theobald in more than one-third (36.1%) of the *Culex* catch. Only 7.8% of the resting site catch was in this category. Some trap-collected specimens were definitely damaged by contact with the fan-blades, and others may have lost their diagnostic markings while crowded in the trap bag or by poor packing in storage tubes. It is important to note, however, that the mosquitoes collected by Gravid Trap were probably older, because they were mostly gravid and therefore confined to cohorts corresponding to the end of each gonotrophic period. Allowing 2 days for eclosion and mating, and a further 4 days for the full gonotrophic cycle, most of these mosquitoes would have been more than 6 days old, and the remainder either 10 or 14 days or older. By contrast, up to 60% of samples from the resting sites were probably nulliparous (D. B. Francy, unpublished data), including large numbers of freshly emerged specimens. In view of this age difference and the ease with which the diagnostic markings on the scutum are lost, it is not surprising that specimens collected by Gravid Trap were more difficult to identify.

Resting site collections from Memphis have yielded virus isolates in every year from 1974 through 1982 (D. B. Francy, Ft. Collins, CO, unpublished data). In this period, 351 virus isolates were made, including 51 of SLE. In September 1982, during initial development of the Gravid Trap, SLE virus was isolated from two of 30 pools of *Cx. pipiens* s.l. (377 mosquitoes). In 1983, however, despite a catch which was larger than the total for the previous 6 years combined, not a single isolation was made from either Gravid Trap or resting site collections. Avian serologic evidence confirmed unusually low SLE transmission (MSCHD, unpublished data), and the same was true for all the central United States (Centers for Disease Control 1983).

CONCLUSION

The CDC Gravid Mosquito Trap proved to be an effective device for collecting large numbers of live, gravid *Culex* mosquitoes. As a quantitative sampling tool, it provides a workable and efficient means for the routine surveillance of urban *Culex* species. The species composition of the catch facilitates rapid processing, and its age composition should be advantageous in the quantitative surveillance of *Culex*-borne pathogens. These features should favor its use in the study and surveillance of SLE and several other important diseases, including Japanese encephalitis and bancroftian filariasis.

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