EVALUATION OF OVITRAPS IN THE U. S. AEDES AEGYPTI ERADICATION PROGRAM

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Elimination of a species entails a tremendous amount of surveillance in target areas before certification of eradication can be granted. The surveillance technique employed must be reliably sensitive at the low population levels encountered during the attack or control phase, as well as during the consolidation and verification phases. The development of the ovitrap (Fay and Perry, 1965; Fay and Eliason, 1966) provided a potential new approach to surveillance for *Aedes aegypti*. Studies in 1966 at the Florida Field Research Activities, Aedes aegypti Eradication Program (unpublished data) indicated that distribution of ovitraps on a grid pattern (350 or more feet) warranted further investigation as a means of detecting the presence and distribution of this species.

Developmental studies of grid distribution of ovitraps were conducted during 1967 in operational areas of the Program having both high and low *Ae. aegypti* populations. The ovitrap surveillance technique was found to offer an economical and reliable means of determining the distribution of this species in areas having relatively high population densities (Jakob and Bevier, 1969). Low indices were found in urban situations of South Carolina, Florida and Texas, which had been under eradication pressures since as early as 1964. Active measures included continued source reduction activities and the cyclic application of residual insecticide. The results obtained with ovitraps in these areas with a minimum number of remaining *Ae. aegypti* foci, as determined by the prevailing surveillance technique, comprehensive larval surveys, are presented.

MATERIALS AND METHODS. Ovitraps were placed in Columbia, Florence, Greenville, and Spartanburg, South Carolina; Tampa and Key West, Florida; and Laredo and Waco, Texas. Traps were distributed on a zone-wide basis on grids of 400 and 500 feet, and on a "tight" grid which approximated a 250-foot equilateral spacing or two traps per average size block (300 x 500 feet). Efforts were made to use each grid pattern in zones which originally were heavily infested, lightly infested, or not infested based on inspections for larvae. The number of traps placed in each locality was determined in part by the availability of manpower for such duties which would be compatible with other necessary activities of the work force. The number of traps operated in the various locations ranged from 1,100 to about 4,000, with the exception of Key West which had 604 traps.

Ovitraps were serviced at weekly intervals according to procedures previously outlined (Jakob and Bevier, 1969). The water level in the jars was adjusted so that the paddle would remain moist for the servicing interval. Thus, in a given area the amount of water used weekly during cooler months was considerably less than that required during the hot summer period.

When an ovitrap paddle was found with *Ae. aegypti* eggs (ovitrap positive) area personnel were expected to conduct an inspection around the positive trap for

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the breeding source of the ovipositing female. Generally, such inspections were limited to a one- or two-block area around the block on which the positive ovitrap was found. In some locations, however, a zone-wide comprehensive larval inspection had been previously scheduled to be conducted during the time that these field trials were in progress.

RESULTS AND DISCUSSION. The choice of grid patterns to be evaluated was a compromise between the logic which assumes that the greater the number of stations the more thorough the sample and the minimum number of traps per unit area which might be adequate to maintain the required sensitivity of surveillance. The selection of the expanded grids also recognized that surveillance in a program of broad geographical dimension should ideally require a minimum amount of manpower and cost to be acceptable and feasible.

The number of ovitrap positives found in the various study areas is shown in Table 1.

The Tampa area was an outstanding example of progress towards eradication. Nevertheless, 36 ovitrap positives were obtained during the period of early May (week 18) to mid-October (week 42). Most of the positives (86.1 percent) were found in zones with past histories of heavy *Ae. aegypti* infestation. Six of the positives were found in a single zone on blocks adjacent to a Post Office warehouse receiving intrastate mail shipments from various infested cities. Although extremely difficult to prove, adult importation was a likely possibility in this situation.

In Key West, ovitrap positives were obtained from early April (week 15) to early December (week 49). The majority (69.2 percent) were found in zones with originally high *Ae. aegypti* indices. Surveys in response to positive ovitraps led to the location of larval breeding on 21 premises. Importation of adults was suspected in the case of three ovitrap positives due to their remote location from possible breeding sites. More than 80 percent of the cars parked in the vicinity of one of these suspect importations were from out-of-state or other Florida counties.

TABLE 1.—Summary of ovitrap activities in advanced areas of the Aedes aegypti Eradication Program, 1967.

Location	No. zones	No. ovitraps	No. positive ovitraps	No. zones with ovitrap positives
Tampa	26	4019	36	13
Key West	12	604	13	7
Laredo	13	1200	3	2
Waco	21	2172	6	1
Greenville	8	1761	8	5
Spartanburg	8	1905	9	3
Florence	8	1190	26	6
Columbia	13	1883	2382	13

The low number of positives obtained in these subtropical areas of high *Ae. aegypti* potential despite the operation of hundreds of traps reflects the complexity of eradication of this species and the sensitivity of ovitrap surveillance. It also indicates that elimination within a limited geographical area and the lack of adequate safeguards against importations compound the chances of reinfestation and possible generation of undiscovered foci.

The low number of positives found in Laredo may be related to the severe climatological conditions common to the location. Only 3.2 inches of precipitation occurred during the 23-week period from early March to mid-August. Lack of rainfall coupled with the high temperatures prevalent in the area may have drastically reduced the hatching potential of eggs remaining in containers. In mid-

August, however, 5 inches of rain fell during a 7-day period and about 2 weeks later (week 35) two ovitraps in a zone were found to contain *aegypti* eggs. The 2-week interval represents the time required for hatching, larval development, first blood meal, and maturation of eggs. Additional rainfall preceded the finding of a positive ovitrap in another zone during week 41. All ovitrap positives in Laredo occurred in zones with past histories of *Ae. aegypti* infestation.

Ovitrap positives in Waco were found beginning in week 38 (mid-September) and all were located in a zone which had not previously been found positive by larval inspections. In addition, the positives were obtained in blocks of the zone which had never been treated. The rather late appearance of such positives is unexplainable but may have been due to importations or movement from an adjacent undetected infestation.

Initial ovitrap positives occurred in Greenville and Spartanburg, South Carolina, during week 17 (late April). Fewer than 10 positives were found in each of these locations during the 32-week trial period. Four of the positives in Greenville occurred between weeks 27 and 36 during which time six ultra low volume (ULV) aerial applications of malathion (3 oz./A.) were made. After the third such application, in conjunction with supporting ground activities, no ovitrap positives were recorded for a 10-week period. At Spartanburg only two ovitrap positives were found during the application of a series of six ULV aerial treatments (weeks 27 through 36). The breeding sources were not found.

In Florence, South Carolina, *Ae. aegypti* oviposition continued to be recorded despite a series of 10 aerial applications to the area (weeks 24 through 40) and ground control measures in response to ovitrap positives. One trap became positive after cessation of aerial sprays. In this locality ovitraps revealed the existence of an infestation on a premises, access to which had been denied inspection personnel by the owner.

Ovitrap positives were found in all zones under study in Columbia, South Carolina. The distribution and frequency of positivity strongly indicate that low levels of population had not been reached, and that progress toward eradication was slower than in other areas chosen for ovitrap evaluations.

The zones found positive at more than one ovitrap servicing interval during the study period are listed in Table 2. The majority of recurring positives were found in zones which were originally heavily infested. On the basis of the number of positives found in these zones (Table 2) and the total number of positives in the locality (Table 1) more than 60 percent occurred in a limited number of the zones under ovitrap surveillance, except in Key West. Such data emphasize the difficulty of *Ae. aegypti* eradication and the reliability of ovitrap surveillance. Although all grids used are represented in the tabulation, it is impossible to ascribe superiority to any one grid because the level of infestation at the start of the study and the ecological situations favorable to *Ae. aegypti* breeding were unknown and probably varied considerably from zone to zone. Logistically, the wider grids would be preferred since a greater area could be covered at lower cost. The data do indicate the feasibility of using 400- or 500-foot grids. The degree of infestation buildup or spread before foci are detected by ovitraps at such distributions requires further study. The spatial relationship of the trap to the foci might be expected to determine in part the interval before the infestation is detected.

It is not within the scope of this paper to give results of all inspections conducted in response to ovitrap positives. Such surveillance did result in the finding of larval breedings, often within a two-block area of the ovitrap. Conversely, such inspections in other instances did not result in locating larval breeding. Although larval breeding sites, even when found, cannot be definitely incriminated as the source from which an ovipositing female originated, the ovitrap has served as a

TABLE 2.—Zones found positive by ovitraps during more than one weekly servicing interval, 1967.

Location	Zone No.	Number positives	Number weeks positives found	Grid Used
Waco	(a)	6	5	500
Tampa	(a)	3	3	500
	(b)	5	5	500
	(c)	2	2	400
	(d)	2	2	400
	(e)	4	4	400
	(f)	2	2	400
	(g)	2	2	tight
	(h)	3	3	tight
	(i)	9	6	tight
Key West	(a)	3	3	400
	(b)	3	3	tight
Greenville	(a)	3	3	400
	(b)	2	2	tight
Spartanburg	(a)	2	2	500
	(b)	5	5	tight
Florence	(a)	5	5	500
	(b)	10	6	400
	(c)	7	6	tight

signal that further oviposition is probably taking place.

Operational records indicate that a marked reduction in manpower was possible with ovitrap surveillance in contrast to comprehensive larval surveys. Inspectors were capable of servicing 80 to 100 ovitraps per day while those in larval survey averaged only two to three blocks. In Tampa, for example, only 55 man-days were required with ovitrap surveillance in the 26 study zones as compared to more than 950 man-days for a comprehensive larval inspection. The advantages of the weekly reading offered by ovitraps over larval surveys at 2- or 3-month intervals cannot be overemphasized. In addition to lower cost, the discovery of *Ae. aegypti* in areas with negative larval inspections indicates that ovitraps provide a more sensitive and reliable system of surveillance.

CONCLUSIONS. The ovitrap has been shown to be an economical, rapid, and sensitive means of detecting *Ae. aegypti* activity in an area even though population densities are very low. The weekly indication of oviposition activity provided by the ovitrap is less dependent for success on rainfall than are inspections for larvae. The reliability of ovitraps distributed on expanded grids of 400 or 500 feet has been demonstrated. More extensive use of ovitraps is necessary to define the ultimate sensitivity and limitations of this surveillance technique.

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