DEVELOPMENT AND EVALUATION OF THE ARMY IMPROVED PORTABLE IMMATURE MOSQUITO CONCENTRATOR SYSTEM[1]

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ABSTRACT. An improved portable immature mosquito concentrator system was developed and evaluated under laboratory and field conditions. In laboratory tests using 2500 *Culex pipiens* Linnaeus immatures, 99.8% of the specimens were captured by the concentrator system. When *Aedes taeniorhynchus* (Wiedemann) immatures were used, 93.7% of the specimens were captured. Excluding 1st instar larvae, the system caught 99.9% of the 4000 specimens used in the combined test. During field evaluation of the system, the contents of 100 dips made in a salt marsh habitat were concentrated into 10 collection and storage vials. Of 6803 *Ae. sollicitans* (Walker) collected larvae, 100% of the specimens were captured by the improved immature mosquito concentrator system.

INTRODUCTION

Surveys for immature mosquitoes are important aspects of an effective mosquito surveillance and control program. They are used to determine the location, species and population densities of pestiferous and medically important mosquitoes. They are vital for predicting adult emergence and establishing optimal times for application of larval control measures. They are utilized to forecast program needs for implementation of adult mosquito control as well as to assess adequacy and effectiveness of both chemical and biological control measures.

The automatic device for the collection of aquatic specimens (ADCAS) made by Earle (1956) was the first widely used concentrator system for the collection of immature mosquito specimens. Earle developed the ADCAS to reduce unacceptable losses experienced when using the pipette and bottle system commonly employed for concentrating collections from dippers.

Due to expense or limited portability due to size and/or weight of early concentrator systems (Earle 1956, Womeldorf et al. 1963, Warren and Eddleman 1965), Husbands (1969) developed a relatively small, portable, lightweight concentrator system comprised of a hollow, brass tee with hinged funnel and handle. A collection vial with a 60-mesh screen was placed into the system to collect the immature mosquitoes as they were poured through the unit. Miura et al. (1970) reported that when the concentrator system of Husbands was employed, time requirements for mosquito surveys were reduced by two-thirds with no difference in information obtained. Fanara (1973) reported that, when the screen vial in the concentrator system of Husbands became clogged with foreign matter, specimens would be lost with the overflow. This problem led Fanara to develop a settling system fabricated from a funnel modified with screen side panels and having a gas valve fitting at the base. Although this system was lighter, cheaper and easier to fabricate, it was somewhat awkward and time-consuming to use in the field because of its configuration and specimen collection procedures.

The purpose of this research was to develop a compact, lightweight, portable system that could be effectively used in the field to concentrate mosquito larvae and pupae. The intended system should be compatible for use in conjunction with

[1] The opinions, assertions, and product names contained herein are the private views of the authors and are not to be construed as official or as reflecting the views or endorsements of the Department of the Army or the Department of Defense.

the standard pint-dipper collection technique for collecting immature mosquitoes.

METHODS AND MATERIALS

An immature mosquito concentrator system (Figure 1) was fabricated with modified commercially available materials and parts made from commercial standard stock items.[2] The system consists of 2 basic components: the concentrator base unit (A-E) and the collection and storage vial assembly (F-I).

The primary component of the concentrator base unit is a standard polyvinylchloride (PVC) 3-inch to 1-1/2-inch reducing coupling (B), which serves as a receptacle funnel. A 3/4-inch diameter flat hole, 3/16-inch deep is drilled into the side of the funnel 3/4 inches from the top. This hole provides a flush fitting to attach the handle, a 6-inch long, 3/4-inch diameter PVC rod (C). The handle is fastened to the funnel with PVC pipe cement.

A bushing (D) is fabricated from a 1-inch section of 1-1/2-inch diameter, schedule 40 PVC pipe. The top is beveled at 48° to give a flush fit when the bushing is cemented into the base of the funnel with PVC pipe cement. A 29/64-inch deep, 1-47/64-inch diameter hole is bored into the bottom of the bushing to provide a seat for the thread insert (E). The thread insert is made by cutting the top out of the screw cap of a dollar-size coin storage tube. The thread portion is then cemented into the base of the bushing with a cyanoacrylate ester base glue.

A 3-9/16-inch diameter removable coarse screen (A) is cut from 4 × 4-mesh galvanized woven wire cloth. This is depressed into the large end of the funnel to form a snug friction fit.

Components of the collection and storage vial assembly are two 2-inch clear butyrate tube bodies (G) with screw caps (F) (commercially available silver dollar storage tubes), a 5/8-inch diameter collection screen (H) cut from 40 × 40 mesh monel wire cloth with 0.010-inch diameter wire and a 3/8-inch connector ring (I) cut from 1-3/4-inch clear butyrate tube stock. The 2 silver dollar coin storage tubes are cut to give 2-inch tube sections (G). These sections are assembled with the collection screen between them. This joint and the connector ring which encircles it are cemented with a cyanoacrylate ester base glue.

The immature mosquito concentrator system is utilized by removing both screw caps (F) from the collection and storage vial assembly and screwing either end into the bottom of the concentrator base unit. Contents of dips are poured into the funnel of the base unit. The water containing mosquito larvae and pupae passes through the coarse screen, which strains out large debris. It then passes through the 1-1/2-inch diameter hole in the base into the collection and storage vial. Immature mosquitoes are trapped on the collection screen in the center of the vial assembly and the water passes out the bottom of the system.

Once collecting has been completed at a site or after a given number of dips have been concentrated, the cap is screwed onto the bottom of the vial and 20 to 100 ml of water are poured into the system to maintain the specimens concentrated in the container. The collection and storage vial assembly is then unscrewed from the concentrator base unit and capped. The unit may then be transported to another locale where the contents can be identified and analyzed.

Laboratory evaluation of the immature mosquito concentrator system was conducted using laboratory-reared mosquitoes in tap water. Twenty-five immature mosquitoes were introduced into beakers filled with 100 and 250 ml of water. Contents were poured into the concentrator system and the effluent was collected in a white enamel pan and checked for specimens. Determinations were made of the number of specimens the collection system caught as well as the

[2] The items which must be purchased are measured in inches by the manufacturers, and use of the metric system in such cases would lead to confusion.—Editor.

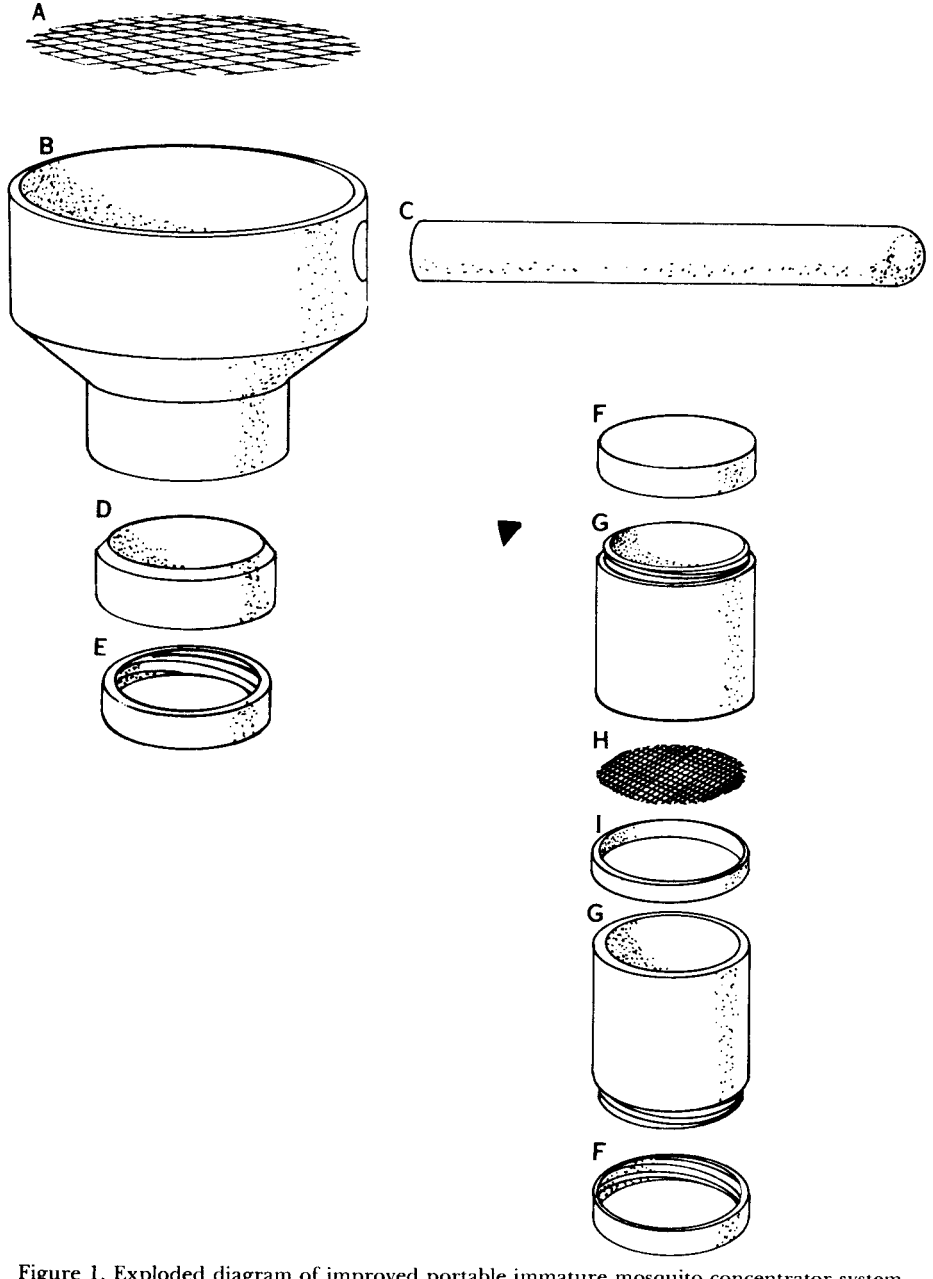

Figure 1. Exploded diagram of improved portable immature mosquito concentrator system.
A-E Concentrator base unit; A Coarse screen; B Funnel; C Handle; D Bushing; E Thread insert;
F-I Collection and storage vial assembly; F Screw cap; G Tube body; H Collection screen; I Connector ring.

number it failed to catch. This test was replicated 10 times using *Culex pipiens* Linnaeus and *Aedes taeniorhynchus* (Wiedemann). Pupae and each larval instar were evaluated separately.

Field evaluation of the system was conducted in a salt marsh habitat near Wallops Island, Virginia. Two collectors and one observer participated in this evaluation. Each collector, using a 400 ml plastic dipper, concentrated 10 dips each into 5 separate collection and storage vials. While the collector was pouring the contents of the dipper through the concentrator system, the observer held a pail under the unit to catch the effluent and count any immature mosquitoes missed. The observer watched the collection vial and subjectively determined if the unit became clogged and to what degree. This was rated on a scale of 0-5. Zero represented uninterrupted flow and 5 indicated the unit was totally clogged.

Once field collections were complete, the collection and storage vials were taken to the laboratory where the mosquitoes were identified, counted and their stage of development determined. The number of specimens other than mosquitoes was also noted for each series of collections.

RESULTS AND DISCUSSION

In laboratory evaluations using *Cx. pipiens* in 100 ml water (Table 1), the system was successful in capturing 99.2 and 99.6% of first and second larval instars, respectively. One hundred percent of thirds, fourths and pupae were also caught. For *Cx. pipiens* in 250 ml water (Table 2), 99.6% of first instars were captured, while 100 percent of seconds, thirds, fourths and pupae were captured.

With *Ae. taeniorhynchus* immatures in 100 ml water (Table 3), 76.4% of first instars and 100% of seconds, thirds, fourths and pupae were captured. For *Ae. teaniorhynchus* in 250 ml water (Table 4), the concentrator system captured 62.0 and 98.8% of the first and second instars respectively. One hundred percent of the thirds, fourths and pupae were captured.

Combined data (Table 5) for both *Cx. pipiens* and *Ae. taeniorhynchus* revealed catches of 96.8% of the 5000 immatures passed through the concentrator. Excluding first instars, the system captured 99.9 percent of specimens used in the combined test.

Earle (1956) reported losses by experienced collectors using the pipette and bottle system to be 23, 4 and 8% for early instars, late instars and pupae, respectively. When 2000 early instars, 2000 late instars and 1000 pupae were used to evaluate the concentrator system, losses were found to be 8.0, 0.0 and 0.0%, respectively. This represents a 2.88 fold increase over the pipette and bottle system of collecting and concentrating early instars from the dipper. If a collector is unwilling to accept this loss, a finer mesh screen may be used in the collection and storage vial assembly. If a finer mesh screen is used, the probability of the system clogging is increased.

In field evaluations (Table 6), the concentrator system captured 100 percent of the 6803 *A. sollicitans* larvae collected.

Table 1. Range and mean percent *Culex pipiens* immatures in 100 ml. water captured in ten replicates by improved portable immature mosquito concentrator system

Developmental Stage	Total Specimens		Percent Captured	
	Captured	Missed	Range	Mean
1st Instar	248	2	92–100	99.2
2nd Instar	249	1	96–100	99.6
3rd Instar	250	0	100–100	100.0
4th Instar	250	0	100–100	100.0
Pupa	250	0	100–100	100.0
Total	1247	3	92–100	99.8

Table 2. Range and mean percent *Culex pipiens* immatures in 250 ml. water captured in ten replicates by improved portable immature mosquito concentrator system

Developmental Stage	Total Specimens		Percent Captured	
	Captured	Missed	Range	Mean
1st Instar	249	1	96–100	99.6
2nd Instar	250	0	100–100	100.0
3rd Instar	250	0	100–100	100.0
4th Instar	250	0	100–100	100.0
Pupa	250	0	100–100	100.0
Total	1249	1	96–100	99.9

Table 3. Range and mean percent *Aedes taeniorhynchus* immatures in 100 ml. water captured in ten replicates by improved portable immature mosquito concentrator system

Developmental Stage	Total Specimens		Percent Captured	
	Captured	Missed	Range	Mean
1st Instar	191	59	64–88	76.4
2nd Instar	250	0	100–100	100.0
3rd Instar	250	0	100–100	100.0
4th Instar	250	0	100–100	100.0
Pupa	250	0	100–100	100.0
Total	1191	59	64–100	95.3

Table 4. Range and mean percent *Aedes taeniorhynchus* immatures in 250 ml. water captured in ten replicates by improved portable immature mosquito concentrator system

Developmental Stage	Total Specimens		Percent Captured	
	Captured	Missed	Range	Mean
1st Instar	155	95	52–80	62.0
2nd Instar	247	3	96–100	98.8
3rd Instar	250	0	100–100	100.0
4th Instar	250	0	100–100	100.0
Pupa	250	0	100–100	100.0
Total	1152	98	52–100	92.2

Table 5. Combined range and mean percent *Aedes taeniorhynchus* and *Culex pipiens* immatures captured in 40 replicates by improved portable immature mosquito concentrator system

Developmental Stage	Total Specimens		Percent Captured	
	Captured	Missed	Range	Mean
1st Instar	843	157	52–100	84.3
2nd Instar	996	4	96–100	99.6
3rd Instar	1000	0	100–100	100.0
4th Instar	1000	0	100–100	100.0
Pupa	1000	0	100–100	100.0
Total	4839	161	52–100	96.8

Table 6. *Aedes sollicitans* larvae and other aquatic specimens collected during field evaluation by the improved portable immature mosquito concentrator system

	Mosquito Larvae Instars				Other	
	1st	2nd	3rd	4th	specimens	Total
Number Collected	1.	320.	815.	5667.	88	6891.
Percent of Total Collection	0.0	4.6	11.8	82.2	1.3	100.
Percent Missed	0.0	0.0	0.0	0.0	0.0	0.0
Percent Captured	100.	100.	100.	100.	100.	100.

First through fourth instars were present in the 100 samples dipped; no pupae were found. However, 88 other aquatic insects, primarily Hemiptera and Coleoptera, were also collected.

Although large numbers of specimens were present in samples processed, up to 2943, clogging of the system was not found to be a problem in the field evaluation. Only 2 collections showed any clogging; both were minimal and neither interfered with field concentrating operations. Calculated mean clogging value in the field evaluation on the scale of 0-5 was 0.3.

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