Table 1. Average numbers of larvae per 400 ml dip sample after flooding 25 test plots and the ratios of *Ae. nigromaculis* to *Ae. melanimon.*

	Burned				Unburned			
Date Flooded	No. Plots	No. Dip Samples	$\bar{x}$ An:Am[1]	$\bar{x}$ Larvae Per Sample	No. Plots	No. Dip Samples	$\bar{x}$ An:Am	$\bar{x}$ Larvae Per Sample
6/13	4	105	1:1.2	10.6	3	70	1:3	22.7
6/21	5	125	1:1.6	3.4	5	125	1:1.6	8
6/27	4	80	1.2:1	5.5	4	80	1:1.4	8.7

[1] An is *Ae. nigromaculis.* Am is *Ae. melanimon.*

1973) and therefore are located in a zone below the fire which often did not produce the 66°C and higher temperatures which would kill the eggs. It appears then, that many of these eggs, because of their proximity to ground level, escaped the lethal high temperatures found higher in the flames, and thereby remained viable through subsequent flood irrigation and hatching. We have therefore concluded from these studies that the winter burning of dormant pastures as described is not likely to achieve satisfactory control of these 2 mosquitoes.

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CONSOLIDATION OF LARVAE AFTER SEPARATION OF PUPAE IN THE MASS PRODUCTION OF *ANOPHELES ALBIMANUS* WIEDEMANN

JOYCE E. F. FOWLER AND DONALD L. BAILEY

Insects Affecting Man and Animals Research Laboratory, USDA, AR, SEA, Gainesville, Florida 32604

ABSTRACT. Experiments showed that consolidation of larvae remaining in rearing trays after the 2nd harvest of pupae was feasible and beneficial in mass rearing *Anopheles albimanus* Wiedemann. Consolidation after the 1st harvest is not recommended, because the size of the resulting pupae and the production from survivors in rearing trays are reduced.

INTRODUCTION

A major consideration in the mass rearing of insects is conservation of space, especially when several days are required from the time eggs are set in rearing containers until the desired life stage has been harvested. Also, with some insects, several days may be required for harvesting because of differential developmental time of the immature stages. When this is the case, after some of the insects have been removed from the rearing containers, consolidation of the remaining younger life stages into fewer containers reduces the space required for

rearing. Ford and Green (1972) usually consolidated the larvae of *Anopheles albimanus* Wiedemann from 2 trays into 1 after the 1st harvest of pupae, after the 2nd harvest, the remaining larvae were discarded. Dame et al. (1974) consolidated *An. albimanus* larvae from 2 rearing trays into 1 after the 2nd harvest of pupae and discarded the remaining larvae after the 3rd harvest. From the ca. 2000 newly-hatched larvae they put into a rearing tray they estimated about 90% (1800) were recovered as pupae with 3 harvests. Bailey et al. (1979b) used the same type of rearing container as Dame et al. (1974) but used greater numbers and different techniques for setting trays and for feeding the larvae. They harvested pupae on 3 consecutive days and did not consolidate trays, producing an average of 3822 pupae per tray and discarding an average of 1554 larvae per tray (22.9%) after the third harvest. We therefore felt that a more thorough study of the consolidation of *An. albimanus* larvae in their rearing containers might be beneficial. Experiments were conducted with the improved rearing system to determine if consolidation of rearing trays after the 1st and/or 2nd harvest of pupae would be beneficial in mass rearing *An. albimanus*.

MATERIALS AND METHODS

The larvae were reared in ABS plastic rearing trays (56 x 43 x 7.5 cm high). Three liters of water were placed in each tray 24 hr prior to adding the newly hatched larvae to allow the water to reach the desired rearing temperature (29±0.5°C). The water temperature in the trays was maintained by electric heating tapes regulated by electronic proportional controllers (Dame et al. 1978). Just before the newly hatched larvae were poured into the trays (Bailey et al. 1979b) 150 ml of an aqueous suspension containing 2.25 g of liver powder:yeast:hog supplement (1:1:1) was added to the water in each tray, and 72 hr later each tray received another 150 ml of the 1:1:1 mix. On eachof the next 2 days, each tray received 150 ml (3 g dry ingredient) of a suspension of hog supplement in water.

The first pupae were produced on the 6th day after the newly hatched larvae were put in the trays. At the time the pupae were separated from the larvae using the cold water technique described by Bailey et al. (1979a) (modified from Weathersby 1963). Each of the 4 replicates of the experiment consisted of 28 rearing trays, handled as follows:

	*A**	*B*	*C*	*D*	*E*	*F*
No. trays started	2	2	4	8	4	8
No. trays after 1st harvest (day 6)	2	2	4	8	2	2
No. trays after 2nd harvest (day 7)	2	1	1	1	1	1

* Control.

Consolidation of trays after pupal separation was accomplished by combining the larvae from 2 or more trays remaining into 1 tray. The trays in the control group (A) were not consolidated, beginning with 2 trays per replicate and returning the contents of each tray to the original after each pupal separation. The larvae in the remaining trays went through various degrees of consolidation. Beginning with 2, 4, or 8 trays per group, the larvae in some groups of trays (B, C, and D) were not consolidated after the first pupae were removed, however, the larvae in all groups except the control were ultimately consolidated into 1 tray after the 2nd separation.

After each separation the total number of pupae in each group was measured volumetrically and then 1-ml samples were counted to determine the approximate number of pupae per original rearing tray. After the pupae had been separated 3 times, the larvae remaining in each group were measured volumetrically, and the number in a 1-ml sample was counted. Also, after each separation, samples of 300 pupae from each group

were placed in small cages (15 x 25 x 20 cm high), and the number of emerging adults (males and females) was recorded. These adults were then held for 7 days with cotton pads soaked with 10% sugar water, and the percentage surviving was recorded to determine the relative longevity of adults within each groups.

RESULTS AND DISCUSSION

The effects of the different degrees of consolidation on pupal size (as indicated by the number of pupae per ml), pupal production, percent adult emergence, adult survival, the relative size of adults, and the number of larvae that were discarded are reported in Table 1. In general, the size of the pupae was not greatly affected by consolidation. The only exception was that those from the 2nd separation in groups E and F (the only groups that were consolidated after the 1st separation) were somewhat smaller than those from the other groups which were either not consolidated (group A) or were not consolidated until after the 2nd separation (groups B, C, and D). Also the overall average pupal size of all consolidated groups except B was smaller (more pupae/ml); group B underwent the least amount of consolidation.

Table 1. Results of various degrees of consolidation of larvae in rearing trays after beginning to harvest pupae when mass rearing *Anopheles albimanus* (mean of 4 replications).

	Group					
Separation	A	B	C	D	E	F
			No. pupae/ml			
1	274	266	286	276	266	281
2	293	296	289	291	319	312
3	312	306	324	327	324	323
Avg.	293	289	300	298	303	305
			No. pupae/tray			
1	824	966	1309	1085	631	817
2	2232	2359	2334	2332	2313	2322
3	760	499	381	452	517	264
Total	3816	3824	4024	3869	3462	3404
			Percent adult emergence			
1	92.4	91.4	94.5	93.5	91.6	91.5
2	95.4	90.9	91.6	93.1	90.7	92.0
3	64.9	74.8	53.8	61.0	54.4	55.2
Avg.	84.2	85.7	79.8	82.5	78.9	79.6
			Percent adult longevity (males)			
1	91.9	90.0	87.4	90.0	93.1	91.4
2	73.8	77.3	81.8	83.5	81.0	82.7
3	66.1	70.1	65.6	56.4	73.8	53.0
Avg.	77.3	79.1	78.3	76.6	82.6	75.7
			Percent adult survival (females)			
1	91.3	95.0	91.5	96.5	95.7	96.1
2	89.2	91.5	91.6	92.4	88.1	86.0
3	79.0	86.6	79.4	77.0	86.0	82.2
Avg.	86.5	91.0	87.5	88.6	89.9	88.1
			Larvae remaining after 3rd harvest			
No./ml	416	398	425	392	435	433
No./tray	1279	1029	1642	702	1772	1057

The production of pupae per rearing tray exceeded 3800 in all groups that were not consolidated after the 1st separation (groups A, B, C, and D). Groups E and F, which were both consolidated after the 1st separation produced only 3462 and 3404 pupae, respectively; a substantial loss in production. For example, in our present program, we set 300 rearing trays per day so a reduction of 400 pupae per tray would mean 120,000 fewer pupae available each day for release.

The average adult emergence and survival differed little as a result of consolidation. However, this study did indicate that in all groups there was a general decrease in emergence and survival of the mosquitoes related to the number of consecutive pupal separations, attributed at least in part to the additional handling and an additional exposure to ice water with each separation. In general, the pupae were smaller, adult emergence was less, and adult survival was less with each successive pupal separation; and the reductions were especially noticeable in mosquitoes from the 3rd separation. There was also a considerable variation in size and numbers of the larvae discarded, but none of it could be attributed to the methods of consolidation.

The results indicated the feasibility of using a system of consolidation of rearing trays for *An. albimanus,* especially after the 2nd pupal separation. Although the quality of the mosquitoes obtained from the 3rd separation was not as good as that from the 1st and 2nd separations, the extra numbers produced could mean an additional 120,000 sterile males per day in a program the size of ours. On the other hand, the reduced emergence and longevity after the 3rd separation must be considered. If this reduction is acceptable, we especially recommend a 3rd pupal separation when the trays can be consolidated 8 to 1 after the 2nd separation (as in group D), which reduces the work involved in harvesting them the following day 8-fold. However, because of the reduction in pupal size and pupal separation, consolidation after the 1st pupal separation is not recommended.

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