TABLE 1.—Comparative costs—drums vs. bulk.

Base Case—10,000 Gal./Yr. Usage			
Drums—FTL (75 drums or 4145 gallons)		*Bulk*—10,000 gallons	
F.O.B. Bayonne, N. J.	$.7000/gal.	F.O.B. Bayonne, N. J.	$.4000/gal.
Frt. Bayonne—Norfolk	+.0854	Frt. Bayonne—Norfolk	+.0880
	.7854		$.4880/gal.
Less Quantity Discount	—.0800		
Used Drum Value	—.0400		
	$.6654/gal.		

$.6654 per gal. del'd. in drums to Norfolk
.4880 per gal. del'd. in bulk to Norfolk

$.1774 per gal.—net savings, bulk vs. drum purchases

Therefore, based on 10,000 gallon usage per year, a savings of 10,000 x $.1774 per gallon, or $1,774.00, is available by bulk purchases over drum purchases.

It was found that a simple above-ground 10,000-gallon storage tank could be installed at a cost of $2,000. An underground tank of the same capacity would cost $2,400. Hence, it can be seen that one year's savings would more than pay for the cost of installing storage facilities.

In considering bulk storage of Flit MLO, there are other items which should be considered. No special tanks or special pumps are needed, as the product is noncorrosive.

Test results indicate that Flit MLO may be stored in bulk for long periods of time (6 months to 1½ years) without appreciably affecting its effectiveness. These evaluations also include determinations on the product that was subjected to freeze/thaw cycles with similar results.

Care should be taken to eliminate free water from bulk handling and dispensing equipment. Small amounts of water due to tank "sweating" and high humidity do not cause adverse effects. However, gross contamination in the magnitude of 5 percent or greater may noticeably reduce the larvicidal activity. Free laboratory service is available from the supplier to determine the presence of water in the event that contamination is suspected.

Flit MLO, as stated above, is noncorrosive and has very low acute oral and acute dermal toxicity and, therefore, is safe to handle. Its flash point is 270° F as compared to 165° F for Diesel fuel and, therefore, it is not a severe fire hazard.

In Virginia, we have established three bulk storage stations: one at Virginia Beach-Lynnhaven Mosquito Control Commission's yard, one at the Kempsville-Bayside yard, and one in York County. Smaller commissions who may use less than carload lots get their material from one of these stations, thereby saving considerable over their cost if they purchased in drums.

We believe that Flit MLO is a good larvicide and by developing the bulk purchasing plan, we have reduced the cost significantly.

TABLE 2.—Drum handling costs.

$6.00/drum is industry average for drum handling. Includes: Unloading truck, storage, unloading of drums, product left in drum (2–3 gal.), and ordering.
10,000 gallons in 55-gallon drums=180 drums 180x$6=$1080/year in drum handling costs

VIABILITY OF MOSQUITO EGGS PRODUCED BY FEMALE MOSQUITOES DENIED OVIPOSITING SITES[1]

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The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or as reflecting the views of the Navy Department or the Naval Service at large.

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While carrying out experiments with colonized mosquitoes it is frequently necessary to have large numbers of mosquitoes of the same age

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and in specific periods of their life cycle. Although colonies produce all stages of the insect's life cycle at one time or another, many species, including *Culex fatigans,* do not demonstrate a synchronous life cycle such as that found in *Aedes taeniorhynchus.* Thus, when large numbers of a given species of mosquito are required at a specific time either more colonies have to be established or the study is carried out with fewer than desirable numbers.

Many factors influence mosquito egg-laying and development. Bates (1947), working with *Haemagogus spegazzinii* mosquitoes in a temperature-controlled environment, noted that more eggs were laid at 25° C than at 30° C and that egg deposition could be induced a day earlier if temperatures were kept at 30° C. Concerning the role of blood in egg production, studies such as those by Gordon (1922) have determined that *Aedes aegypti* required whole blood for egg development. In other studies, various components of blood and species of animals which are the sources of blood were investigated (Woke, 1937a, b) to determine their influence in *Aedes aegypti* egg production. These studies, however, did little to establish a means for synchronizing production of mosquitoes in their various life stages.

In studies designed to separate various species of mosquitoes on the basis of protein constituents the problem of asynchronized availability of eggs, larvae, and pupae became very apparent. For instance, if the eggs of a given colony of mosquitoes were collected daily over a period of days the required number could be obtained only by holding the first laid eggs under refrigeration. Those eggs held in refrigeration, however, demonstrated a different content of protein when compared to eggs one day old. To overcome this problem it was necessary to synchronize gravid females in their laying of eggs but not at the expense of egg viability.

MATERIALS AND METHODS. One hundred mated nulliparous female mosquitoes were allowed to take a blood meal from mice that were placed in individual cages and provided with a ten percent sucrose sugar solution made available through cotton wicking inserted in Erlenmeyer flasks filled with the solution. Two types of oviposition sites were made available. *Culex fatigans* and *Anopheles maculatus* were provided with open ceramic containers of water and *Aedes aegypti* with a similar ceramic water container which was lined with white filter paper. For each group of mosquitoes four cages were maintained simultaneously as follows: cage 1 had oviposition sites available from the moment of introduction of the mosquitoes; cage 2 had oviposition sites introduced on the fifth day; cage 3 had oviposition sites introduced on the 10th day; and cage 4 had oviposition sites introduced on the 15th day. Eggs deposited in the cages were collected and counted up to and including the

TABLE 1.—Egg-laying incidence of *Culex fatigans.*

	100 fed females			
Day	Cage #1 H_2O—day 1	Cage #2 H_2O—day 5	Cage #3 H_2O—day 10	Cage #4 H_2O—day 15
1	H_2O introduced			
2	0 egg *rafts*			
3	8 live			
4	5 live			
5	1 live	H_2O introduced		
6	1 live	20 egg *rafts*		
7	4 live	11 live		
8	10 live	10 live		
9	3 live	4 live		
10	2 live	4 live	H_2O introduced	
11	3 live	6 live	37 egg *rafts*	
12	4 live	3 live	4 live	
13	2 live	3 live	4 live	
14	4 live	1 live	1 live	
15	3 live	2 live	1 live	H_2O introduced
16	1 live	3 live	1 live	35 egg *rafts*
17	1 live	1 live	1 live	3 live
18	0 live	6 live	4 live	2 live
19	2 live	1 live	2 live (1 failed to hatch)	3 live
20	2 live	0 live	1 live	1 live
21	2 live	0 live	1 live	1 live
Total	58	75	57	45

TABLE 2.—Egg-laying incidence of *Aedes aegypti.*

Day	100 fed females			
	Cage #1 H_2O—day 1	Cage #2 H_2O—day 5	Cage #3 H_2O—day 10	Cage #4 H_2O—day 15
1	H_2O introduced			
2	0 eggs			
3	1176 live			
4	925 live			
5	259 live	H_2O introduced		
6	152 live	616 eggs		
7	202 live	643 live		
8	42 live	418 live		
9	152 live	145 live		
10	67 live	29 live	H_2O introduced	
11	53 live	24 live	210 eggs	
12	38 live	736 live	461 live	
13	147 live	345 live	602 live	
14	49 live	242 live	45 live	
15	23 live	85 live	270 live	H_2O introduced
16	13 live	337 live	120 live	496 eggs
17	13 live	17 live	63 live	263 live
18	72 live	55 live	87 live	167 live
19	157 live	61 live	266 live	420 live
20	59 live	90 live	245 live	245 live
21	37 live	67 live	345 live	366 live
Total	3636	3910	2714	1957

TABLE 3.—Egg-laying incidence by *Anopheles maculatus.*

Day	100 fed females			
	Cage #1 H_2O—day 1	Cage #2 H_2O—day 5	Cage #3 H_2O—day 10	Cage #4 H_2O—day 15
1	H_2O introduced			
2	2452 live			
3	1121 live			
4	116 live			
5	445 live	H_2O introduced		
6	58 live	1632 live		
7	8 live	608 live		
8	35 live	387 live		
9	25 live	6 live		
10	0 live	0 live	H_2O introduced	
11	0 live	10 live	806 live	
12	0 live	0 live	214 live	
13	0 live	62 live	144 live	
14	0 live	0 live	68 live	
15	0 live	0 live	0 live	H_2O introduced
16	0 live	0 live	0 live	342 live
17	0 live	0 live	0 live	215 live
18	0 live	0 live	0 live	148 live
19	0 live	0 live	0 live	18 live
20	0 line	0 live	0 live	0 live
21	0 live	0 live	0 live	0 live
Total	4260	2705	1232	723

21st day after the adult mosquitoes were introduced.

RESULTS AND CONCLUSIONS. Regardless of the species of mosquito or time of ovipositions, all eggs with the exception of a single *C. fatigans* egg raft laid on the 19th day were found to be viable. As indicated in Table 1, most *C. fatigans* egg rafts were laid in the 21-day period when the oviposition sites were provided on the fifth day and the fewest number of egg rafts laid when the ovipositing sites were withheld until the 15th day. Almost identical numbers of viable egg rafts were deposited whether the ovipositing site was provided on the first or the tenth day. Typically, the greatest abundance of egg rafts were laid the day following introduction of the ovipositing site when the site was withheld. A marked change in the total number of rafts produced was seen only in those groups where ovipositing sites were withheld more than 10 days.

Table 2 indicates the egg-laying behavior of *Ae. aegypti* mosquitoes when their ovipositing sites were made available at various intervals. Similar to the findings with *C. fatigans*, the greatest total number of eggs laid in the 21-day period occurred when the ovipositing sites were provided on the fifth day while the fewest eggs were laid when the ovipositing sites were withheld until the 15th day. The *Ae. aegypti* were also similar to the *C. fatigans;* however, *Ae. aegypti* deposited significantly fewer eggs during the 21-day period when the ovipositing sites were introduced on the tenth day as opposed to introduction on the first day.

Table 3 indicates the egg-laying activity of *An. maculatus.* These mosquitoes deposited their eggs over a much shorter period than did the other two species. As in the case of the *Ae. aegypti*, a significant reduction in total eggs produced was noted when ovipositing sites were withheld until the tenth day after the females were introduced into the cages.

SUMMARY. This investigation has shown that (1) the viability of *Aedes aegypti, Culex fatigans,* and *Anopheles maculatus* eggs retained in the gravid female is unaffected; (2) the greatest number of viable *Culex fatigans* egg rafts can be obtained at one time by denying the gravid female an ovipositing site for 5 days or more; and (3) in the case of *Anopheles maculatus* and *Aedes aegypti* the greatest total number of eggs can be obtained by having ovipositing sites constantly available.

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MOSQUITOES AND AGRICULTURE ON OKINAWA [1]

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Throughout the history of mankind agriculture has had a significant impact on the population of mosquitoes in any given geographic region. Sometimes, through his agricultural practices man has inadvertently aggravated mosquito problems by faulty irrigation or poor drainage systems; at other times he has greatly reduced the mosquito problem by draining swamp lands and leveling fields to increase his available crop land. Ordinarily such a progression and procession of changes take place over decades if not centuries.

The island of Okinawa is unique in that in the past 25 years it has changed from an almost totally agricultural economy, chiefly dependent on rice, to a semi-industrialized economy. Ready markets for pineapple and sugar which could be grown on this semi-tropical island helped hasten the agricultural transition from rice grown in flooded fields to crops that could be grown on dry surface fields in both hilly and level areas. As the flora on Okinawa changed so did the fauna. The reduction in the total area of standing sun-lit waters of rice paddies required by *Anopheles sinensis* and *Culex tritaeniorhynchus* not only reduced the numbers of these mosquitoes as pests but decidedly aided the Japanese encephalitis and malaria control programs. However, those relatively level fields covered with organic debris and intermittently laced with

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