than a flow meter to provide continuous and instantaneous information concerning the flow of insecticide leaving the nozzles of a system. It is my belief that, after a few simple tests, few applicators will apply low volume sprays without a flow meter to monitor the output.

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HATCHING OF FLOOD-WATER MOSQUITOES IN SCREENED AND UNSCREENED ENCLOSURES EXPOSED TO NATURAL FLOODING OF LOUISIANA SALT MARSHES

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Many researchers have studied the effect of age and the number of floodings on the hatching of eggs of floodwater mosquitoes in controlled laboratory experiments, but only a few long-term controlled studies have been made in the field. For example, in a recent investigation, Breeland and Pickard (1967) reported the production of nine species of fresh water *Aedes* and *Psorophora* in screened and unscreened enclosures exposed to artificial flooding. Small numbers of *Psorophora confinnis* (Lynch Arribálzaga), *P. cyanescens* (Coquillett), *P. ciliata* (F.), and *P. howardii* Coquillett were still being produced in a screened enclosure after 23 floodings occurring in 4 years. However, two species, *P. ferox* (Humboldt) and *Aedes atlanticus* Dyar and Knab, did not appear in the screened enclosures until the 18th and 21st floodings, respectively, which took place during the fourth year. It may have been coincidental that these two species appeared in the screened enclosures at the same time populations were building up in the unscreened enclosures and in the general area because the ecology of the area was gradually changing to a woodland type habitat more conducive to their breeding.

We wished to find out whether it was possible to use the natural habitats to hatch out all the eggs of our most important species in southwestern Louisiana (*Aedes sollicitans* (Walker), *A. taeniorhynchus* (Wiedemann), and *P. confinnis*) over a period of time. Therefore, several salt marshes were selected for study that had consistently produced broods of these species.

MATERIALS AND METHODS. The vicinity of Big Lake, Louisiana was chosen for the study. Big Lake is connected to the Gulf of Mexico by the Calcasieu ship channel; hence, the areas surrounding the lake are subjected to tidal action, possess salt-marsh vegetation, and often produce enormous broods of salt-marsh mosquitoes and smaller broods of *Psorophora confinnis*.

Eight plots, each 10 feet square (Figure 1) were laid out in two salt-marsh areas, GL-I and GL-II, and walled to a height of about 18 inches above the ground and to a depth of about 6 inches beneath the surface of the soil. The walls were of cedar siding with redwood stock at the corners, and all joints were sealed to ex-

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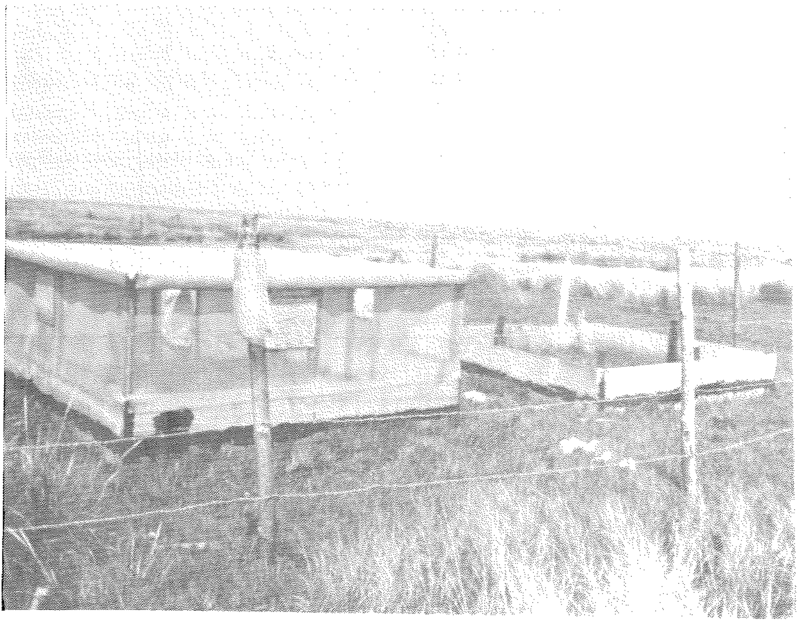

Fig. 1.—A screened enclosure (left) and an unscreened enclosure (right) near Big Lake, Louisiana.

clude the entrance of surface water and mosquitoes. Four were enclosed by screening them to a height of about 4 feet and were provided with access ports on each side for dipping. These ports were covered with a cloth sleeve which was tied shut when it was not in use and covered with a plywood panel (a closed mosquito habitat). The remaining four plots were unscreened to allow continued egg deposition (an open mosquito habitat). The eight plots were arranged in four sets of two plots each, one with a screened and one with an unscreened enclosure. The two plots in a set had been selected so they were nearly duplicates in respect to elevation and vegetation. Two sets were placed in the area designated "GL-I" in which the principal vegetation was *Paspalum vaginatum* Swartz with some small patches of *Spartina spartinae* (Trin.). The other two sets were located in the area designated "GL-II" and were characterized by *Spartina patens* (Ait.), a *Juncus* sp., plus the two species present in GL-I. The plots in GL-II were close to a spoil bank and to a canal whose entrance into Big Lake was plugged.

All eight plots were checked at least once a week from April 1, 1965 to August 21, 1968, or oftener if high tides or precipitation occurred. Normally, 10 dips were made in each enclosure. If mosquito larvae were recovered, they were taken to the laboratory where they were counted and identified. The closed habitats were protected from autogenous eggs by killing any adult mosquitoes that emerged within 3-4 days after emergence (the enclosures were covered with a tarpaulin and lightly misted inside with an aerosol of pyrethrins).

Results and Discussion. The general ecology of the GL-I area and its potential as a habitat for floodwater mosquitoes remained unchanged during the almost four years of observation. Those of the GL-II area were modified when the canal adjacent to the enclosures that opens into Big Lake was unplugged by the land owner in 1966. As a result, the GL-II area was exposed to a much greater tidal action, and the enclosures therefore remained flooded for extended periods; consequently, predation by fish was intensified, and the area was less attractive to ovipositing floodwater mosquitoes.

Figures 2 and 3 show the average weekly water coverage (based on the percentage of the site that was flooded) that existed in the enclosures at GL-I and GL-II, respectively, during the observations. The long periods of 100 percent coverage in both areas show that we were at the mercy of rains and tides since we could not schedule the floodings or drainage of the areas. The figures also show the average weekly number of larvae of *Aedes sollicitans, A. taeniorhynchus,* and *Psorophora confinnis* per dip that were collected in both types of enclosure in GL-I and GL-II, respectively.

The number of broods of the three species produced by the number of floodings in each area is given in Table 1. Eggs of *Aedes sollicitans* were obviously exposed to many more hatchable floodings than eggs of the other two species. However, Woodard *et al.* (1968) reported that *A. sollicitans* continues to breed during the cooler months, but eggs of *A. taeniorhynchus* and *P. confinnis* normally do not hatch during this period; therefore, when larvae of these last two species were no longer present in the general area, the floodings of the enclosures were not counted for these two species since their eggs were incapable of hatching.

As expected, about twice as many broods of *Aedes* spp. were produced in the unscreened enclosures as in the screened enclosures; the difference was not as pronounced with *P. confinnis,* probably because the salinity of these salt marsh areas was so variable. Higher salinities would certainly reduce the oviposition of *P. confinnis* in the unscreened enclosures, which would result in fewer broods of larvae.

The yearly accumulative percentage of the total populations for the three species in the screened enclosures and the accumulative number of floodings are shown in Table 2. The percentages were derived by totaling the number of larvae dipped during the study and then accumulating these as percentages of the total population based on the number of floodings (both partial and complete) capable of causing a hatch.

Over a 2-year period, 95 percent of the total population of *A. sollicitans* was depleted by 28 floodings, and the total population had apparently hatched after 41 floodings over 4 years. In contrast, two-thirds of the total population of *A. taeniorhynchus* was exhausted after 10 floodings (during the first year), and total elimination of hatchable eggs was apparently achieved after 20 floodings over 2 years. Complete elimination of the hatchable eggs of *P. confinnis* occurred after 16 floodings in 3 years.

Table 3 confirms that complete (100 percent) floodings of an enclosure compared with partial flooding would produce more broods. More broods of all species were produced when both types of en-

TABLE 1.—Number of floodings and number of broods of mosquitoes produced in screened and unscreened enclosures at Big Lake, Louisiana from 1965–1968.

	No. floodings over No. of broods per type of enclosure per area					
	Unscreened			Screened		
Mosquito species	GL-I	GL-II	Average	GL-I	GL-II	Average
Aedes						
sollicitans	46/31	50/33	48/32	46/18	50/16	48/17
taeniorhynchus	28/15	35/20	32/18	28/8	35/9	32/9
Psorophora						
confinnis	23/7	28/15	26/11	23/5	28/8	26/7

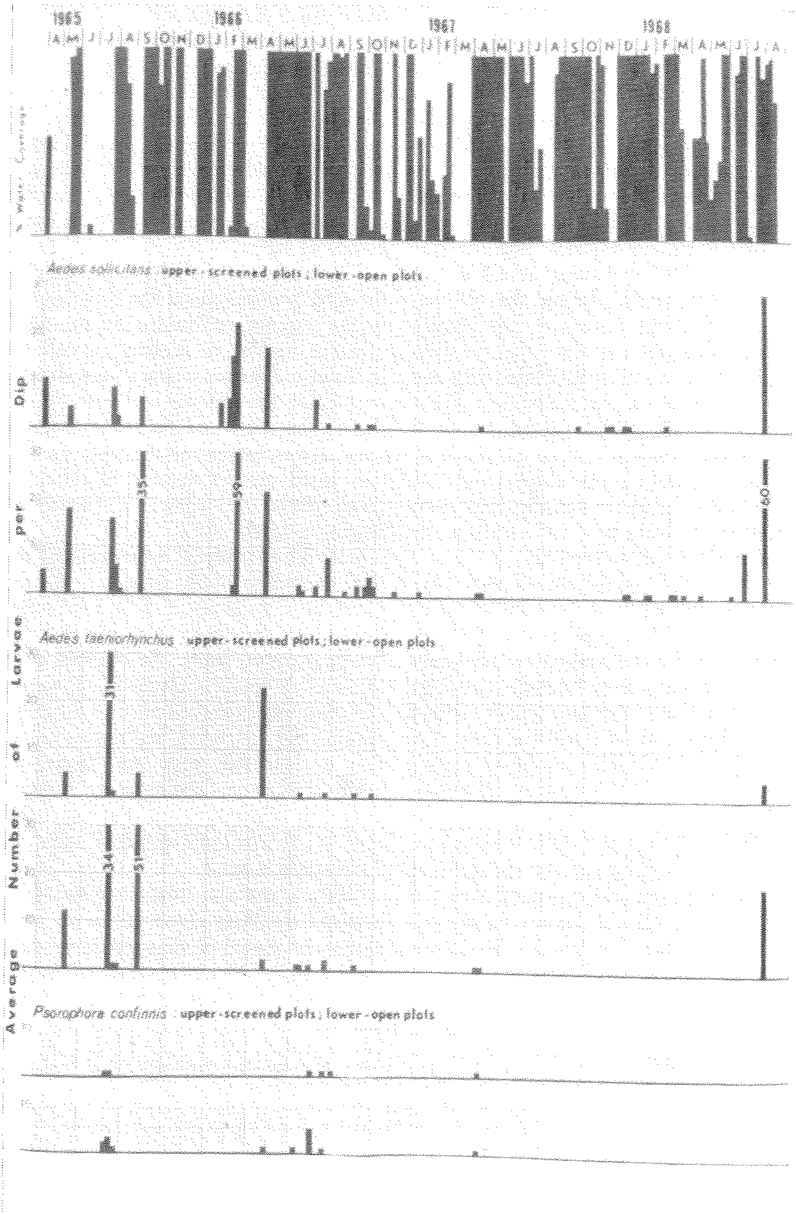

FIG. 2.—Percentage weekly water coverage (average of screened and unscreened enclosures) and the average number of larvae per dip of *Aedes sollicitans*, *A. taeniorhynchus*, and *Psorophora confinnis* in the screened and unscreened enclosures at GL–I from April 5, 1965, to August 21, 1968.

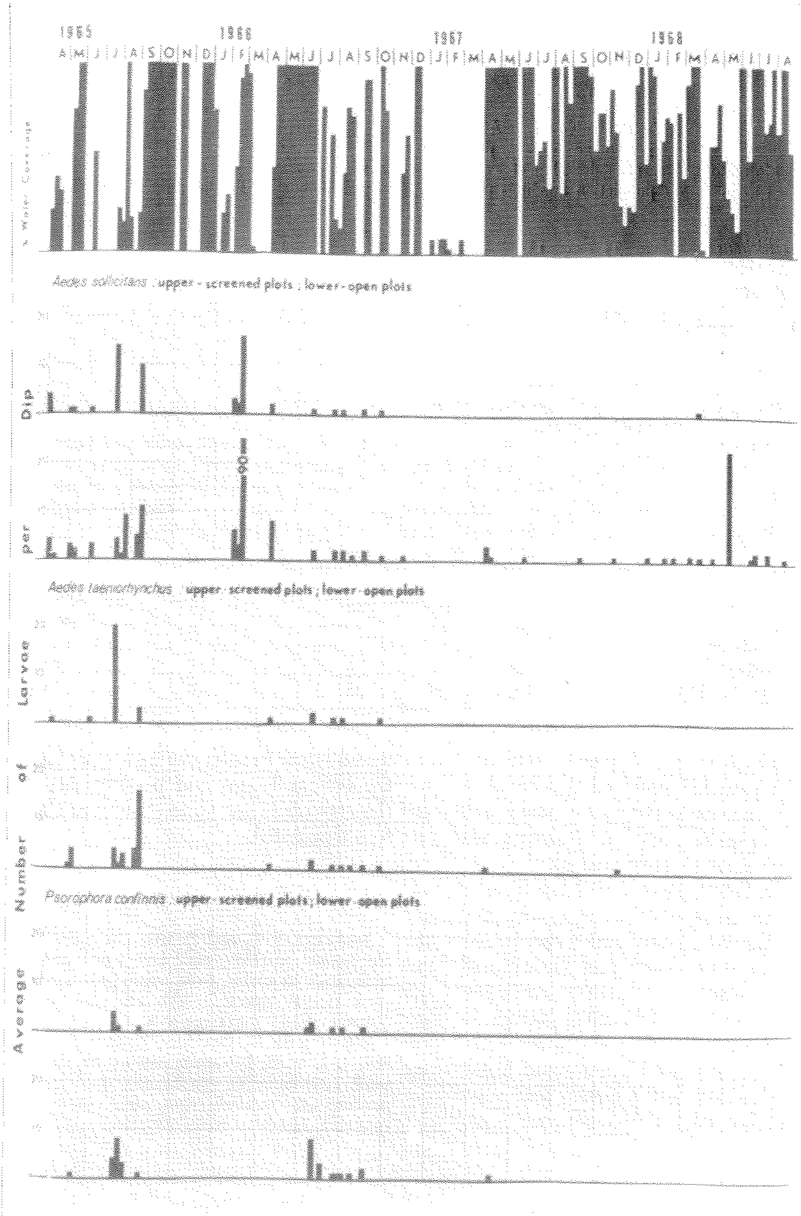

FIG. 3.—Percentage weekly water coverage (average of screened and unscreened enclosures) and the average number of larvae per dip of *Aedes sollicitans, A. taeniorhynchus,* and *Psorophora confinnis* in the screened and unscreened enclosures at GL-II from April 5, 1965, to August 21, 1968.

TABLE 2.—Yearly accumulative percentage of three mosquito species occurring in the screened enclosures and accompanying accumulative number of floodings, Big Lake, Louisiana, 1965–1968.

Mosquito species	1965 Accumulative percentage of total population	1965 No. of floodings	1966 Accumulative percentage of total population	1966 No. of floodings	1967 Accumulative percentage of total population	1967 No. of floodings	1968 Accumulative percentage of total population	1968 No. of floodings
Aedes								
sollicitans	35	13	95	28	99	38	100	41
taeniorhynchus	67	10	100	20	...	..	...	..
Psorophora								
confinnis	44	7	94	15	100	16	...	..

TABLE 3.—Number of broods of three mosquito species produced vs. the degree of flooding of screened and unscreened enclosures, Big Lake, Louisiana, 1965–1968.

Mosquito species	No. broods produced by indicated degree (%) of flooding in Unscreened cages 100	Unscreened cages 99–50	Unscreened cages 49–5	Screened cages 100	Screened cages 99–50	Screened cages 49–5
Aedes						
sollicitans	24	23	17	16	11	7
taeniorhynchus	15	10	10	9	4	4
Psorophora						
confinnis	8	7	7	5	3	5
Average % of total	39	33	28	48	29	23

closures were completely flooded, and about three-fourths of the broods of at least one mosquito species were produced when either type of enclosure was 50 percent or more inundated.

In July 1968, a very large larval population of both *Aedes* spp. was produced in the GL-I area, and large numbers of larvae were observed in the screened (up to 29/dip) and unscreened enclosures (up to 60/dip). Since these larvae in the screened enclosures disappeared the following day and since crayfish holes were also noted, we felt certain that a mechanical breakdown had occurred which allowed larvae to enter the enclosures under the bottom boards and possibly through the crayfish holes. The study was therefore terminated.

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