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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TABLE 1.—Three major agricultural crops on Okinawa in hectares.*

	Sugar	Pineapple	Rice
1960–1961	6,164	2,577	11,728
1961–1962	7,894	3,234	10,520
1962–1963	10,916	3,357	9,717
1963–1964	13,810	3,738	3,901
1964–1965	19,118	4,036	4,066
1965–1966	21,328	4,654	3,469
1966–1967	19,744	5,466	4,312
1967–1968	18,271	5,923	3,935
1968–1969	17,380	5,864	4,274
1969–1970	17,380	5,637	4,571
1970–1971	17,200	5,174	4,387

* Information furnished by the Farm Crop Section, Agriculture and Forestry Division, Government of the Ryukyu Islands.

1 hectare=10,000 sq. meters=2.471 acres.

standing pools of water now provided excellent temporary breeding sites for *Aedes vexans.*

Table 1 reflects the general changes in the area of agricultural crop land used for rice, sugar cane, and pineapple production. From 1960 to 1970 the amount of land utilized for rice production decreased by approximately 63 percent whereas the amount of land used for sugar and pineapple production increased by 179 percent and 100 percent respectively.

Table 2 indicates the total numbers of *Ae. vexans, An. sinensis, C. quinquefasciatus,* and *C. tritaeniorhynchus* adult mosquitoes taken in 25 light traps on Okinawa from 1965 to 1971. Table 3 gives the relative percentages of the total number of mosquitoes trapped for the same four species.

Unfortunately there are no figures available for numbers of mosquitoes that may have been trapped from 1960–1964. Nevertheless, a distinct correlation can be drawn between the declining number of hectares used for rice growing and a steady drop in the populations of *An. sinensis*

TABLE 2.—Selected mosquito species population Trend over a 6-year period.

Year	*Aedes vexans*	*Anopheles sinensis*	*Culex quinque-fasciatus*	*Culex tri-taenior-hynchus*
1965	8,118	23,883	26,577	115,606
1966	19,318	17,994	21,039	155,271
1967	2,166	31,744	15,672	100,500
1968	5,928	9,768	28,540	65,058
1969	30,572	11,130	11,582	26,963
1970	32,994	5,507	14,911	13,380
1971	16,237	4,123	7,770	9,887

TABLE 3.—Percentage of totals of all mosquitoes collected.

Year	*Aedes vexans*	*Anopheles sinensis*	*Culex quinque-fasciatus*	*Culex tri-taenior-hynchus*
1965	4.46	13.12	14.60	63.51
1966	8.74	8.14	9.52	70.28
1967	1.34	19.70	9.72	62.32
1968	5.17	8.51	24.87	56.69
1969	36.16	13.16	13.69	31.87
1970	45.14	7.54	20.40	18.31
1971	38.62	9.81	18.48	23.52

and *C. tritaeniorhynchus.* In reciprocity the number of *Ae. vexans* and their respective proportions of the total of all mosquitoes increased as the hectares for sugar cane production were increased.

Although other geographic areas in the world could demonstrate similar changes in mosquito populations through changes in agriculture, few, if any, would have as clear-cut and dramatic changes as those noted in Okinawa.

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MAN-BITING ACTIVITY OF *AEDES AEGYPTI* IN DJAKARTA, INDONESIA

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