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THE EFFECTS OF DESICCATION ON THE EGGS OF *ANOPHELES QUADRIMACULATUS* SAY

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Anopheline eggs apparently have been found to be fairly resistant to desiccation under experimental conditions. Mayne (1926) reported survival of *Anopheles quadrimaculatus* eggs for as long as 16 days, and survival of *A. crucians* eggs for 21 days when subjected to drying mud. Stone and Reynolds (1939) obtained larvae of *A. punctimacula, A. albimanus,* and *A. aquasalis* from Canal Zone mud which had been devoid of standing water for about one month. Deane and Causey (1943) found some *A. gambiae* eggs able to survive for 18 days in drying sand. Darrow (1949), in a series of critical studies, showed that eggs of *A. quadrimaculatus* had to be kept moist for between 0.2 and 0.3 of the total period of embryonic development in order for them to resist desiccation. She further suggested that eggs on a dry substratum would continue to develop provided the relative humidity was 100 percent.

The present studies were undertaken

to determine if *A. quadrimaculatus* ova could withstand periods of drying in Arkansas rice fields.

Materials and Methods. Crowley type alluvial clay-loam was collected from a delta breeding area near Helena, Arkansas, and silty clay-loam was collected from a Stuttgart rice-field breeding area. Both types of soil were dried and pulverized for uniformity and placed in small aluminum funnels, provided with filter paper liners, to within about ⅜ inch of the top. The spout of each funnel was tightly corked and the funnel filled with tap water. These funnels were then placed in cages containing gravid *Anopheles quadrimaculatus* females collected from specific locations and allowed to remain overnight. The next morning funnels with eggs were removed from the cages, the corks in the funnel spouts withdrawn, and the water allowed to drain so that the eggs could settle on the moist soil surface. All funnels were numbered and placed in racks and the soil in them allowed to dry spontaneously. Eggs on the soil surface in each funnel were counted; eggs on the funnel lips or sides were removed. At approximately 24-hour intervals after desiccation began, funnels were flooded with tap water and counts made of hatching on a 24-hour basis. All experiments were conducted in an inside room without special regulation of temperature and humidity.

Controls for these studies consisted of: (1) funnels on which *Aedes aegypti* oviposited that were flooded after *Anopheles quadrimaculatus* eggs failed to hatch; (2) funnels of eggs from appropriate *quadrimaculatus* strains which were not drained but the eggs allowed to hatch normally—*quadrimaculatus* control No. 1; (3) funnels into which samples of eggs from all experimental funnels were placed and then allowed to hatch normally—*quadrimaculatus* control No. 2.

Data and Discussion. A total of five tests was conducted in which the Q-1 colonized strain of *A. quadrimaculatus* was used each time, the Delta strain on three occasions, and the rice-field strain only once. Table 1 summarizes all of the pertinent data for these tests.

These data suggest that eggs of the colonized strain of *quadrimaculatus* were the least resistant to desiccation. This appeared to be true whether delta or rice-field soils were used or whether the temperature reached maxima of 80° F. or 90° F. The eggs of wild-caught *quadrimaculatus,* whether from delta or rice-field breeding areas, appeared quite similar in their resistance to drying. It is of interest that the initial hatch of eggs from wild-caught mosquitoes was almost always below that of the Q-1 eggs. However, fewer Q-1 ova hatched subsequently than ova from the wild-caught strains.

Actually, the data are too meager to warrant drawing definite conclusions. They do suggest that a drying period of approximately one week would probably be sufficient to kill a majority of wild *quadrimaculatus* eggs on rice-field soils. Similar results were obtained by Hill and Cambournac (1941), who found that drying of Portuguese rice fields for periods of seven days, followed by flooding periods, would reduce anophelines by over 80 percent. The irrigation practices of planters in the Arkansas rice-growing region are such that *quadrimaculatus* have breeding water available throughout most of the growing season. However, depending upon the individual planter, there is usually at least one drainage period during the summer when the soil is permitted to dry until firm enough to be walked on (Nelson, 1944). This is undoubtedly sufficient to kill *quadrimaculatus* eggs.

SUMMARY

1. Observations were made on the ability of eggs of *Anopheles quadrimaculatus* obtained from different sources to survive desiccation under experimental conditions.

2. The data suggest that eggs of the colonized (Q-1) strain of *quadrimaculatus* were the least resistant to desiccation.

3. It is suggested that a drying period of about one week would probably be

TABLE 1. Effect of experimental soil desiccation on hatching of *Anopheles quadrimaculatus* eggs

Exp. No.	Strain	No. of eggs	Soil type	Temperature Range °F.	Relative humidity range %	Percent of eggs hatching Desiccation period in hours: 48	72	96	120	144	168	192	216
1	Q-1	3917	Delta	78–80	35–65	78	69	53	16	2	0	0	—
	quadrimaculatus control #1	600	"	"	"	75	—	—	—	—	—	—	—
	aegypti control	44	"	"	"	—	—	—	—	—	—	—	75
2	Q-1	951	Delta	78–82	35–68	60	71	25	2.7	0	0	0	0
	quadrimaculatus control #1	80	"	"	"	60	—	—	—	—	—	—	—
	quadrimaculatus control #2	111	"	"	"	61	—	—	—	—	—	—	—
	aegypti control	109	"	"	"	—	—	—	—	—	—	65	—
3	Q-1	165	Rice-field	79–87	28–68	55	27	5	0	0	0	0	0
	Delta	2000	"	"	"	23	40	27	21	11	2	0.7	0
	Rice-field	784	"	"	"	56	35	30	18	7	13	0	0
	quadrimaculatus control #1	260	"	"	"	50	—	—	—	—	—	—	—
	quadrimaculatus control #2	254	"	"	"	62	—	—	—	—	—	—	—
	aegypti control	998	"	"	"	—	—	—	—	—	—	—	84
4	Q-1	556	Rice-field	76–89	38–79	62	51	4	2	1	0	0	—
	Delta	932	"	"	"	31	21	37	8	39	0	1	—
	quadrimaculatus control #1	254	"	"	"	46	—	—	—	—	—	—	—
	quadrimaculatus control #2	180	"	"	"	64	—	—	—	—	—	—	—
	aegypti control	992	"	"	"	—	—	—	—	—	—	—	73
5	Q-1	950	Rice-field	78–91	41–66	73	61	40	4	0.4	0	0	—
	Delta	2331	"	"	"	51	59	45	41	7	11	0	0
	quadrimaculatus control #1	266	"	"	"	58	—	—	—	—	—	—	—
	quadrimaculatus control #2	213	"	"	"	60	—	—	—	—	—	—	—
	aegypti control	661	"	"	"	—	—	—	—	—	—	—	87

sufficient to kill a majority of wild *quadrimaculatus* eggs on rice-field soils.

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MOSQUITO CONTROL ON ARMY POSTS IN THE FAR EAST

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Mosquito control at all fixed Army installations in Japan, Okinawa, the Philippines, Guam and Korea is a responsibility of the Post Engineer, as it is in the United States. Utilizing local civilian employees, trained by civilian entomologists in the Corps of Engineers, crews have been established and control operations placed upon regular schedules. The work was supervised by American civilian and enlisted men, by locally employed entomologists and by local crew members who demonstrated abilities of such calibre as to warrant their being given further specialized training and higher responsibility. Close coordination has been maintained between the Engineer organizations and the Army Medical Service, whose survey and control units conduct all operations in combat areas, and whose survey and laboratory units under the direction of Medical Service entomologists have been an integral part of the program.[6] In 1946, most of these control units of the Army Medical Service had been rapidly deactivated and until the local civilian crews could be recruited and trained, operations were often quite unsatisfactory. However, in every area, both the local employees and the American civilians and enlisted men proved to be interested in the work, energetic and capable, and soon developed a high morale and a very considerable efficiency.

Principal Species of Mosquitoes: The principal disease-bearing mosquitoes and their primary breeding places were as follows: *Anopheles hyrcanus sinensis*—(rice paddies); *Anopheles maculatus*—(streams); *Anopheles minimus flavirostris*—(clear streams); *Anopheles subpictus*—(swamp and mud holes); *Aedes albopictus*—(scrap yards, flooded ruins, water containers); *Culex quinquefasciatus* (*fatigans*)—(stagnant water, water con-

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