



FIG. 2.—Series of sani battery quail cages. Each battery maintains up to 10 quail.

and other universities. In addition to physiology, the *Coturnix* quail is used in research in such disciplines as embryology, genetics, pharmacology, and nutrition. The availability of *Coturnix* quail and the ease with which they are maintained in a laboratory make them an ideal host candidate for ornithophilic mosquitoes. In addition to their small size, they have a light plumage and are easily restrained for introduction into colony cages. Moreover, both *C. tarsalis* and *C. pipiens pipiens* readily take blood from these birds.

Quail and inexpensive equipment for the care and housing of them are available from commercial suppliers. Figure 2 shows a series of sani battery cages (Marsh Farms, Garden Grove, California) available in single units to accommodate up to 10 quail each. These cages can be suspended from a ceiling in a storage closet or attached to a wall with adjustable shelving. Sani battery cages come supplied with a paper

belt for easy cleaning; soiled paper can be rolled up, torn off, and thrown away each day, thus eliminating odor, scraping and washing of cages, and accumulating droppings in which flies can breed.

To feed mosquitoes, an adult quail is restrained in a small wire-mesh cage then placed inside a 45 x 45 x 60 cm. Gerberg mosquito cage. Generally, quail are introduced into the colony before the beginning of a 90 min twilight period programmed into our rearing facilities. Quail remain with the colony during the night and are removed the next morning. Most females of both *C. tarsalis* and *C. pipiens pipiens* feed to repletion when exposed to quail under these conditions. In one check, 189 of 200 female *C. pipiens pipiens* took a blood meal 5 days after emergence from pupae collected in the field.

For ease in handling, cleanliness, and acceptability by *Culex* mosquitoes, *Coturnix* quail are unusually good hosts for laboratory colonies of ornithophilic species of mosquitoes. A quail manual (Marsh Farms) provides instructions for incubating, feeding, sexing, and preventing disease in laboratory colonies of *Coturnix* quail. Researchers rearing quail must remember that special care is required to provide temperature control during the first 2 weeks. Quail are mature and begin laying eggs at about 6 weeks.

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X- AND GAMMA RAYS COMPARED AS STERILANTS FOR MALE *Culex pipiens quinquefasciatus* SAY¹

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Culex pipiens quinquefasciatus Say (= *fatigans* Wiedemann) is one of the species of mosquitoes most likely to be controlled with a sterile-male release program. Investigations into the possibility of using this method of control have been conducted all over the world in the past few years. Ramakrishnan *et al.* (1962) reported that male sterilization was obtained with 7,000 R of gamma rays. Krishnamurthy *et al.* (1962) in a small-scale

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field trial found that the release of sterile males into the native population was apparently followed by an increase in the percentage of rafts with embryonated but unhatched eggs. Mulla (1964) used apholate to treat both larvae and adults in sterilization studies on both sexes. Murray and Bickley (1964) and Das (1967) also used apholate to sterilize males and found that these males were sexually competitive with normal males. Smittle *et al* (1968) reported that males treated with apholate had a higher degree of sterility without impairing their competitiveness than did males exposed to gamma rays.

The studies reported here were made at the Insects Affecting Man Investigations Laboratory at Gainesville, Florida, to compare the effectiveness of X- and gamma rays in producing sterility in male *C. p. quinquefasciatus*. Either or both sources may be needed in a program involving the release of sterile males.

MATERIALS AND METHODS. The X-ray source was a General Electric Maxitron Therapy 300 unit with an 0.04 inch aluminum filter that was operated at 300 kV and 20 mA; The dose rate was 400 R per minute as measured with a Victoreen Condenser R-meter. The gamma-ray source was a Cobalt-60 unit similar to that described by Jefferson (1960); it was producing 410 R per minute at the beginning of these tests and 370 R per minute at the termination.

The mosquitoes used in this study were obtained from a colony started with egg rafts collected near Gainesville, Florida, that had been reared in the laboratory for 10 generations. The adult males were separated from the females within 4 hours after emergence, placed in cages constructed of screen wire and cardboard, and irradiated within 10 hours after emergence. After irradiation, 50 irradiated males and 50 virgin nonirradiated females were transferred to 16 x 24 x 25-cm. aluminum cages covered with tubular gauze and provided with 10 percent sugar water. Three days were allowed for mating before the females were offered a blood meal (1- to 14-day-old chickens). Then 3 or 4 days later paper cups containing hay infusion water were placed in the cages to serve as the oviposition medium. Each egg raft collected was placed in a separate cup. After the 3 days allowed for hatching, percentage sterility was determined by comparing the number of unhatched eggs with the total number of eggs.

RESULTS AND DISCUSSION. The results of the exposure of mosquitoes to doses of irradiation ranging from 5 to 20 kR are shown in Table 1. The values are averages for 2 to 9 replications of each exposure, each consisting of 20 to 231 egg rafts and 4452 to 48,572 eggs. An exposure of 5 kR, from either X- or gamma rays, produced over 80 percent sterility. At exposures below 12 kR, X-rays produced slightly more sterility than gamma rays; above 12 kR, both sources produced over 99 percent sterility. (Doses of 16 through 20 kR produced 100 percent sterility in

TABLE 1.—Effectiveness of X- and gamma rays in producing sterility in adult males.

Treatment (kR)	Average sterility (%) induced by	
	X-ray	Gamma ray
5	86.89	81.23
6	95.03	87.49
7	96.53	93.64
8	98.44	95.29
9	99.36	97.45
10	99.48	98.87
11	99.72	
12	99.63	99.65
13	99.81	99.70
14	99.85	99.82
15	99.96	99.92
16	100.00	100.00
17	100.00	99.97
18	100.00	100.00
19	99.98	99.99
20	100.00	99.99
Control (unirradiated)	2.10	1.94

some replicates, but in others, 1 to 3 eggs hatched.) Of the 56,143 eggs produced by females mated with males exposed to 16 to 20 kR of X-rays, only 2 hatched. Of the 40,177 eggs produced by females mated with males exposed to 16 to 20 kR of gamma rays, only 5 hatched. However, many of the larvae that hatched where the males had been exposed to more than 12 kR may have resulted from the "induced parthenogenesis" which Laven (1967) reported might occur in up to 0.69 percent of the eggs when the sperm stimulate the egg without any other contribution.

These tests indicate that both X- and gamma rays could be used at the same doses to sterilize male *C. p. quinquefasciatus* for a sterile-male release program.

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